

(NASA-CR-156511) UNIFIED S-BAND TRACKING
AND COMMUNICATIONS COVERAGE OF THE MANNED
SPACE FLIGHT NETWORK DURING EIGHTEEN EARTH
REVOLUTIONS AT 105 NM ALTITUDE FOR LAUNCH
AZIMUTHS AT 72, 80, 90, 100, AND 108 DEGREES 00/17

N78-75925

Unclas
56332

BELLCOMM, INC.

SUBJECT: Unified S-Band Tracking and
Communications Coverage of the
Manned Space Flight Network
During Eighteen Earth Revo-
lutions at 105 NM Altitude for
Launch Azimuths at 72, 80, 90,
100, and 108 Degrees - Case 215

DATE: July 9, 1965

FROM: J. P. Maloy

ABSTRACT

The purpose of this study was to determine the trend of Apollo USB tracking and communication coverage for individual stations as the launch azimuth and revolution vary for the first day's orbiting of a space vehicle, which could be useful in outlining tentative Apollo test mission plans.

An analysis was made to determine the tracking and communications coverage for 14 Unified S-band stations for 18 earth orbit revolutions on launch azimuths 72°, 80°, 90°, 100°, and 108° at a space vehicle altitude of 105 NM. The results are presented in charts showing how coverage varies with launch azimuth in the 72-108° range for each revolution.



FACILITY FORM 802	X65-38052	X67-89398
	(ACCESSION NUMBER)	(THRU)
	44	2A
	(PAGES)	(CODE)
	CR 67882	07
	(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

~~Available to NASA Offices and
NASA Centers Only~~

BELLCOMM, INC.

SUBJECT: Unified S-Band Tracking and
Communications Coverage of the
Manned Space Flight Network
During Eighteen Earth Revolu-
tions at 105 NM Altitude for
Launch Azimuths at 72, 80, 90,
100, and 108 Degrees - Case 215

DATE: July 9, 1965

FROM: J. P. Maloy

MEMORANDUM FOR FILE

Introduction

The attached Figures 1-36 show the tracking and communications coverage for the Unified S-band stations listed in the preceding legend for eighteen revolutions* and for launch azimuths of 72°, 80°, 90°, 100°, and 108° at an earth orbital altitude of 105 NM. The data was accumulated with the aid of a computer program. (1)

The legend gives the coordinates of the land stations included plus the Insertion Ship. Two locations were used for the ship, one at a northerly position to meet coverage requirements for launch at the higher azimuths (72°-90°), and one at a more southerly location for the higher launch azimuths to provide the required coverage during launch and for five minutes after insertion. The stations are listed starting with Bermuda since it is the first station whose coverage circle is entirely east of the longitude of Cape Kennedy and proceeding in an easterly direction.

Fourteen Unified S-band stations were considered (excluding ships except for the Insertion Ship). The decision to provide Unified S-band equipment at Grand Bahama Island had not been made when this study was initiated. Although GBI will be important in providing coverage during launch, it will not add significantly to USB coverage during earth orbit since

*Eighteen passes through the longitude of Cape Kennedy.

~~Available to NASA Offices and~~
~~NASA Center Staff~~

It is located in close proximity to other USB stations of the U.S. complex.

Assumptions

The time in this study is referenced to launch. The STL Reference Trajectory Data Package indicated that all trajectories considered (one at 72° launch azimuth; three at 90° ; and one at 108°) had essentially the same launch profile. Therefore, the same time to insertion into earth orbit was used for all launch azimuths (11.9 minutes). No coverage during the launch phase is shown here but is the subject of another memorandum.⁽²⁾ The charts show at what time from launch a particular station will make contact with the space vehicle in addition to the relative position of coverage by each station with respect to one another and the length of time for each coverage contact. The search interval of the computer program used in this study was one minute. Any contacts of less than one minute shown in the data are fortuitous. These comments regarding the time reference and the search interval represent improvements over a prior analysis.⁽³⁾

Like the previous study the coverage data presented does not include irregularities in the antenna pattern caused by local masking above 5° , antenna keyhole effects, or ship orientation. Also, handover from one station to the next, acquisition time, or quality of tracking data at different elevation angles of the space vehicle from the site were not taken into account.

The data is based on an earth orbital space vehicle altitude of 105 NM (the nominal test mission altitude) and a perfect circular orbit was assumed. For circular orbits of a higher altitude, the coverage time for each station would, of course, be greater, as for all elliptical orbits whose perigee would be greater than 105 NM.

Description of Figures

Figures 1 through 18 present data on communication coverage to 0° elevation angle from the site and Figures 19-36 show the tracking coverage information for elevation angles of 5° and greater from the site. At a glance, one can detect the density of coverage for each revolution for a launch azimuth and compare one launch azimuth against the

others. They show pictorially where the areas of greatest continuous coverage lie and how coverage overlaps among stations and conversely where coverage is sparse and how great the gaps are between successive contacts.

These figures use time from launch as the ordinate and launch azimuth as the abscissa and consequently show by revolution how the coverage varies with launch azimuth. The contours were plotted from the computer data derived from the five basic launch azimuths of 72°, 80°, 90°, 100°, and 108°. All shapes were projected where applicable by dashed lines to where the coverage duration was estimated to be one minute.

Observations

It can be seen from the figures that the maximum tracking coverage from pickup at 5° elevation from the site to drop out at the same elevation angle is approximately 5.2 minutes. Similarly, maximum communication coverage from horizon to horizon is approximately 7.3 minutes for an over-head pass.

The figures indicate that there is no S-band coverage with greater than one minute duration on the following revolutions:

<u>Launch Azimuth</u>	<u>Comm.</u>	<u>Tracking</u>
72°	--	9
80°	11	8,11
90°	10	7,10
100°	--	6,9
108°	6	6.9

This condition could be alleviated by judicious placement of injection ships.

In general, the coverage density (number of contacts per revolution) is greater for the early revolutions and the later revolutions included in this study. The middle range of revolutions, from approximately the fifth to the thirteenth for the higher launch azimuths starting with 72° and from the third to the tenth for azimuths approaching 108°, have many fewer contacts. Such trends could be significant in considering operational maneuvers during test missions.

The figures show where a USB station has significant tracking contact in relation to the other USB station contacts, thus revealing a picture of coverage effectiveness for the revolution shown using all of the USB stations or some combination thereof. It is significant to note that not all USB stations have the same support capability. Antigua, Bermuda, Canary Islands, and Guaymas will be able to support only a single spacecraft (1 transmitter, 2 data receivers) while all the others will have a dual capability (2 transmitters, 3 data receivers). For a particular test mission, the availability of S-band equipments must be taken into account in planning coverage.

It is anticipated that all USB stations will be operational prior to the first manned Saturn V test mission. Unmanned test missions prior to that time can utilize the stations as they achieve network simulation conditions three months after installation.⁽⁴⁾ Stations may be used on a when available basis for various test missions and their assistance in tracking and communications coverage can be extracted from the figures in this memorandum.

J. P. Maloy
J. P. Maloy

2021-JPM-crr

Attached:

Legend, Figures 1 - 36

Copy to

Messrs. J. K. Holcomb/MAO
T. A. Keegan/MA-2
J. T. McClanahan/MAO
L. M. Robinson/OTDA

C. A. Beers/MSC
D. Broome/MSC
E. L. Chicoine/MSC
H. C. Kyle/MSC
L. Packham/MSC

T. A. Barr/MSFC
O. P. Ely/MSFC
H. Golden/MSFC
J. W. Harper/MSFC
O. A. Hoberg/MSFC

Continued Next Page

BELLCOMM, INC.

- 5 -

Copy to

Messrs. O. M. Covington/GSFC

W. P. Varson/GSFC

P. V. Dimock - BTL/WH

R. K. Chen

E. M. Coombs

J. P. Downs

W. W. Ennis

P. L. Havenstein

J. J. Hibbert

J. D. Hill

J. A. Hornbeck

M. W. Hunter, II

J. E. Johnson

B. Kaskey

H. Kraus

D. S. Kutch

T. F. Loeffler

H. S. London

C. A. Lovell

C. R. Moster

H. Pinckernell

J. T. Raleigh

I. M. Ross

J. J. Schoch

R. L. Selden

P. F. Sennewald

G. H. Speake

T. H. Thompson

J. M. Tschirgi

R. L. Wagner

A. G. Weygand

Central File

Department 1023

Library



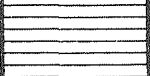
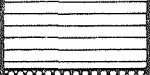











BELLCOMM, INC.

REFERENCES

- (1) "A General Computer Program to Assist in Computing Space Communication Information", Bellcomm, Inc. Memorandum for File, H. Pinckernell, August 19, 1964.
- (2) "Apollo Saturn V Unified S-Band Communications and Tracking Coverage From Lift-Off Through Insertion", Bellcomm, Inc. Memorandum for File, J. P. Maloy and H. Pinckernell, March 19, 1965.
- (3) "Apollo Network Tracking Coverage During Sixteen Earth Revolutions at 105 NM Altitude for Launch Azimuths at 72, 80, 90, 100, and 108 Degrees", Bellcomm, Inc. Memorandum for File, J. P. Maloy, April 10, 1965.
- (4) "A Review of Manned Space Flight Network Implementation Schedules", Goddard Space Flight Center, April 21, 1965.

LEGEND FOR FIGURES 1 - 36

UNIFIED S-BAND STATIONS

STATION	ABBREVIATIONS ⁽¹⁾	LATITUDE ⁽²⁾	LONGITUDE ⁽²⁾	CODE ⁽³⁾
BERMUDA	BDA	32.35N	64.65W	
ANTIGUA	ANT	17.14N	61.79W	
INSERTION SHIP	INS-S1	25.50N	47.00W	
	INS-S2	22.00N	47.50W	
CANARY IS	CYI	27.74N	15.60W	
ASCENSION	ASC	7.95S	14.41N	
MADRID	MAD	40.25N	3.43N	
CARNARVON	CRO	24.88S	113.71E	
GUAM	GUM	13.50N	145.00E	
CANBERRA	CAN	35.32S	149.13E	
HAWAII	HAW	22.13N	159.67W	
GOLDSTONE	GLD	35.39N	116.85W	
GUAYMAS	GYM	27.96N	110.72W	
AUSTIN	TEX	30.30N	97.76W	
CAPE KENNEDY	KEN	28.48N	80.58W	

(1) ABBREVIATIONS HAVE BEEN USED ON ALL FIGURES.

(2) THESE LATITUDES AND LONGITUDES WERE USED AS INPUTS TO THE COMPUTER TO ACQUIRE COVERAGE DATA.

(3) THESE CODES WERE USED ON FIGURES 1-36.

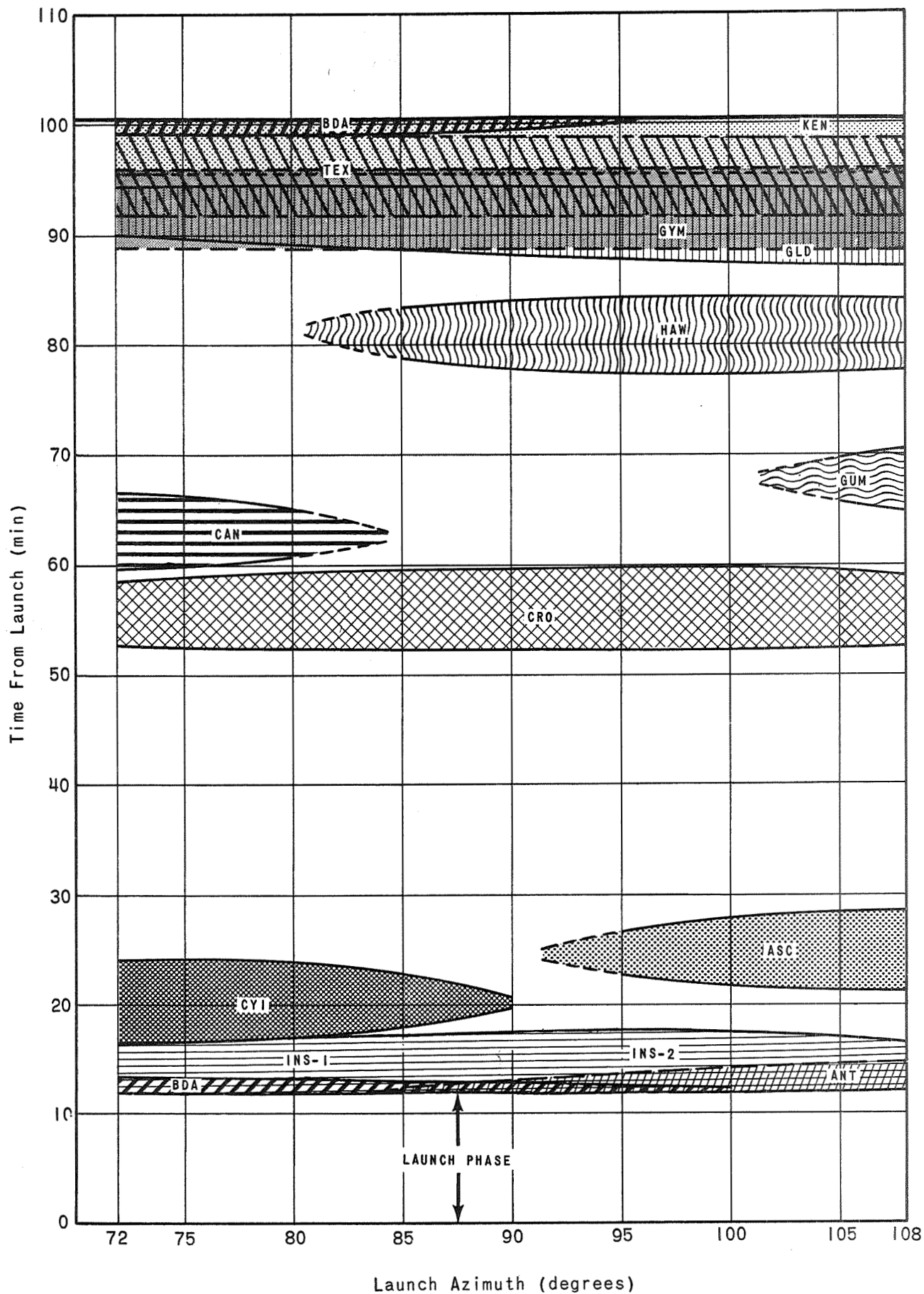


FIGURE 1 COMMUNICATIONS COVERAGE (0° ELEV.)
FIRST REVOLUTION (0 - 100.3 min)

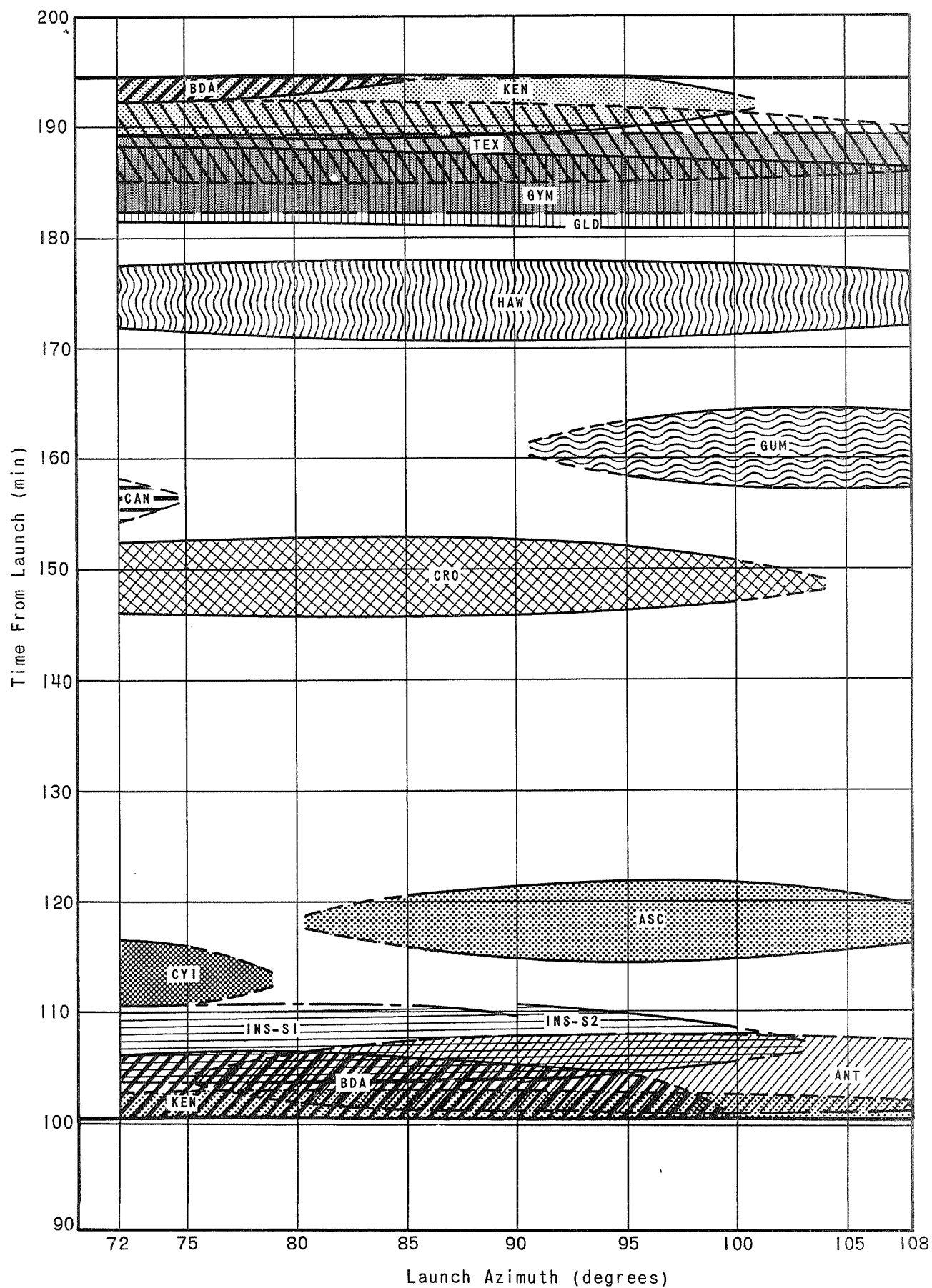


FIGURE 2 COMMUNICATIONS COVERAGE (0° ELEV.)
SECOND REVOLUTION (100.3 - 194.6 min)

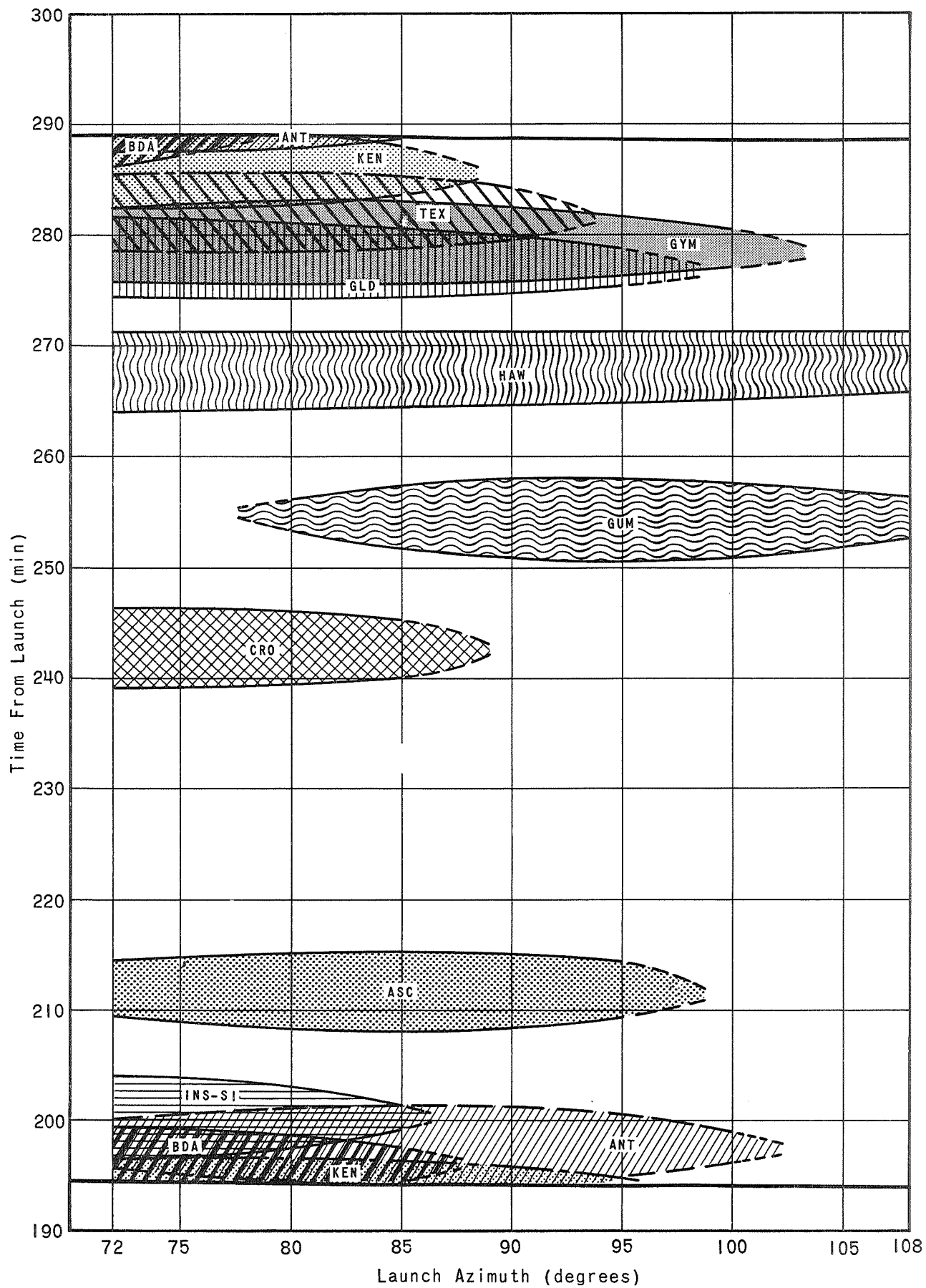


FIGURE 3 COMMUNICATIONS COVERAGE (0° ELEV.)
THIRD REVOLUTION (194.6 - 288.9 min)

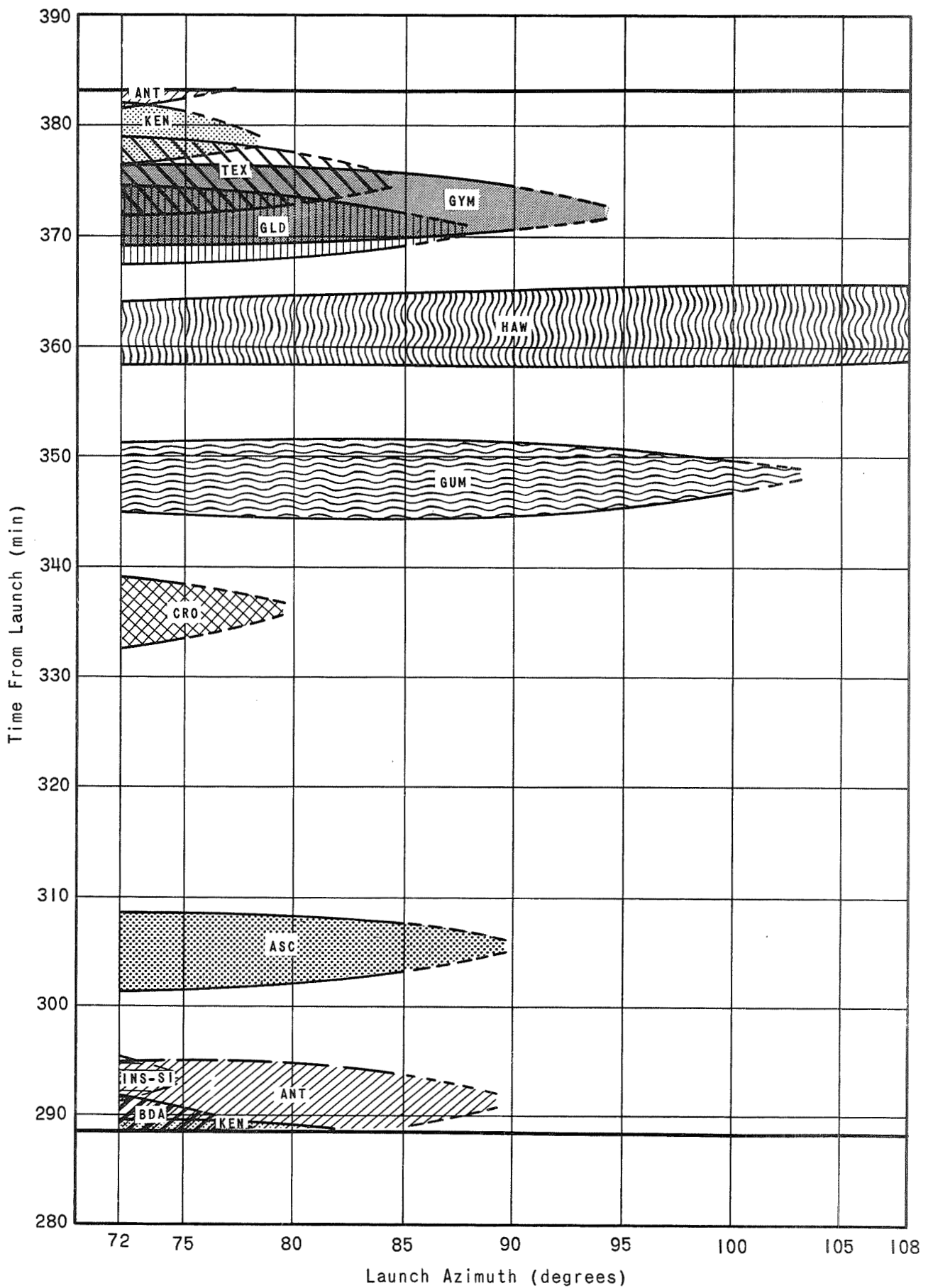


FIGURE 4 COMMUNICATIONS COVERAGE (0° ELEV.)
FOURTH REVOLUTION (288.9 - 383.2 min)

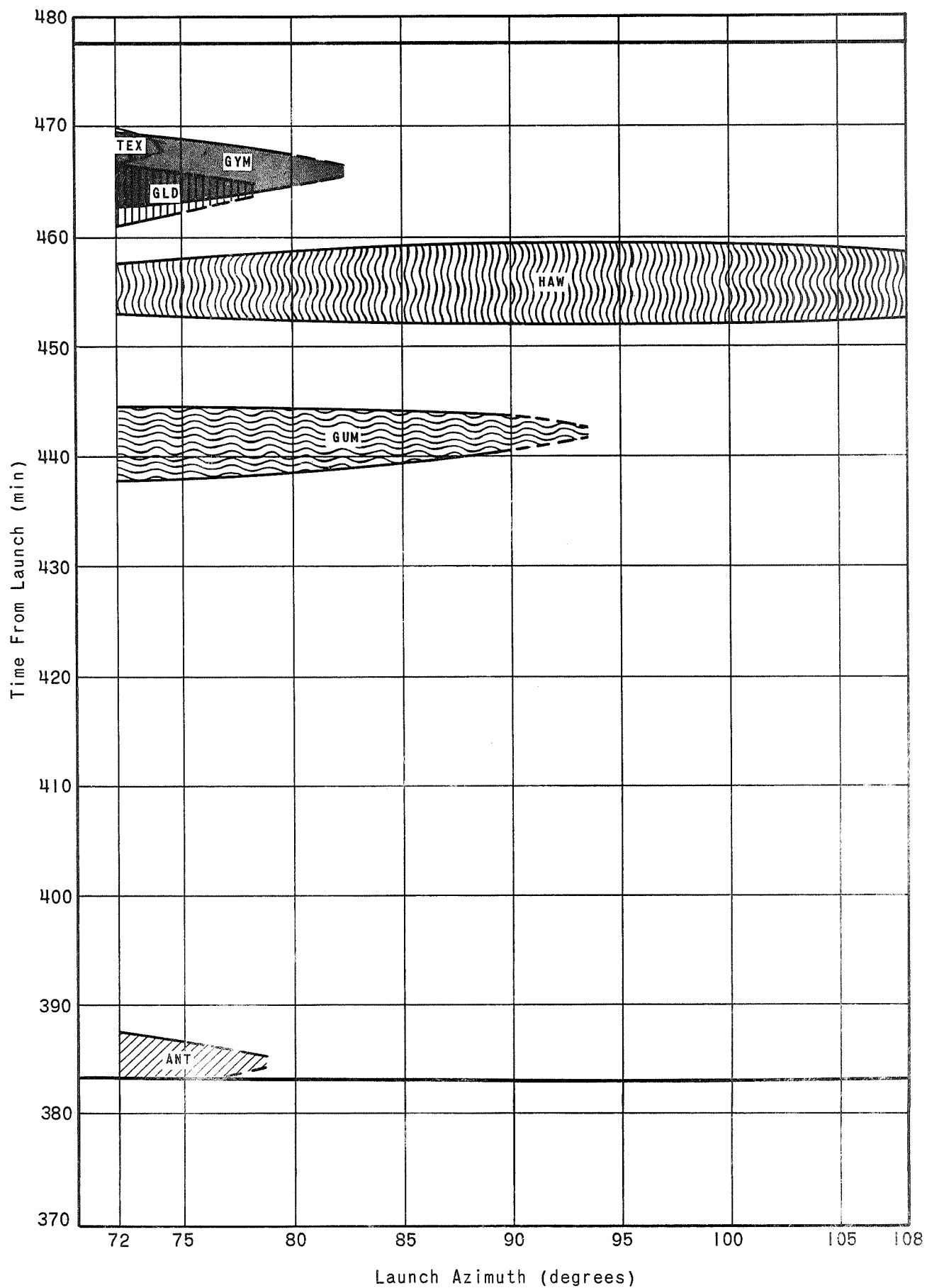


FIGURE 5 COMMUNICATIONS COVERAGE (0° ELEV.)
FIFTH REVOLUTION (383.2 - 477.5 min)

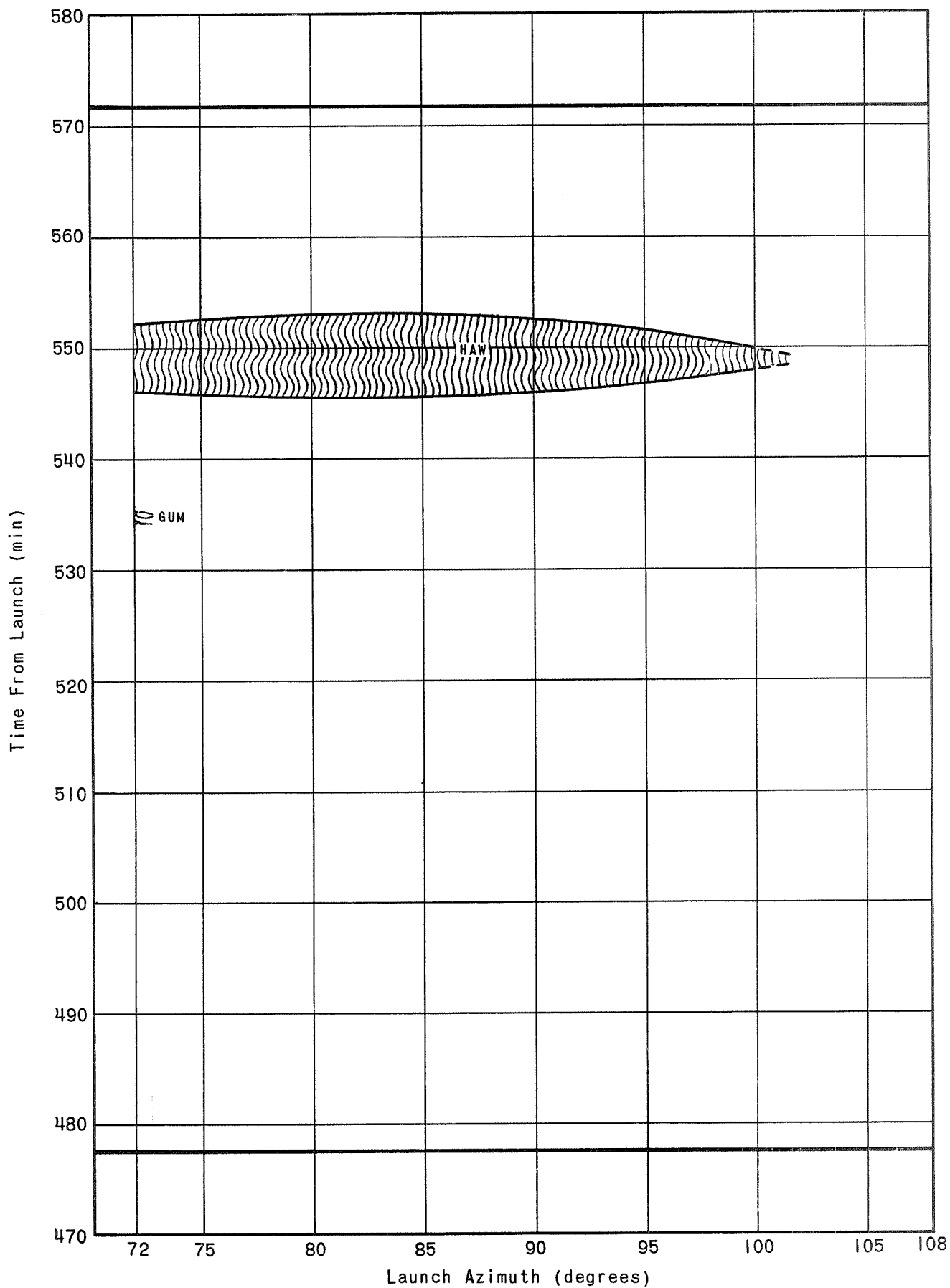


FIGURE 6 COMMUNICATIONS COVERAGE (0° ELEV.)
SIXTH REVOLUTION (477.5 - 571.8 min)

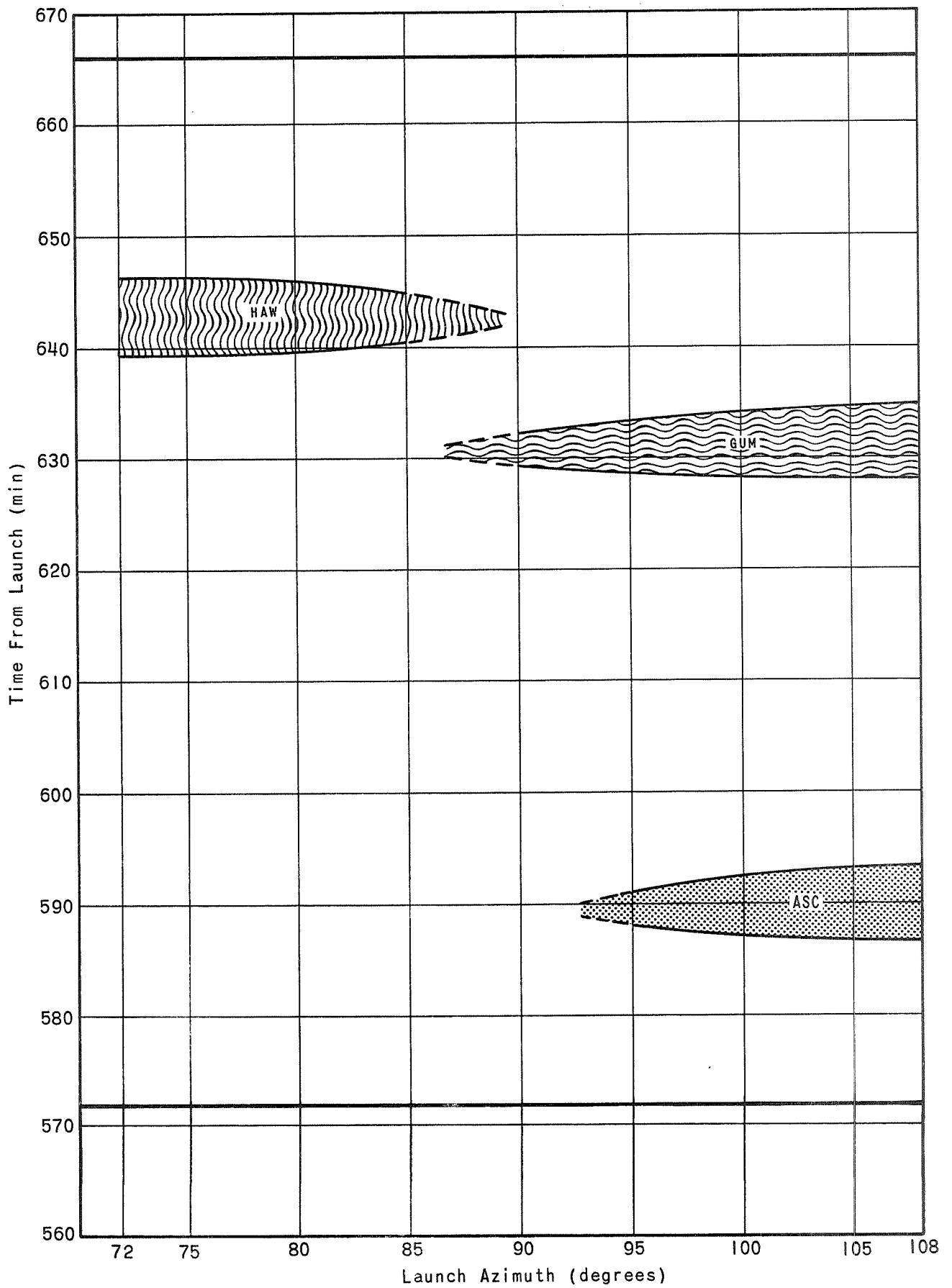


FIGURE 7 COMMUNICATIONS COVERAGE (0° ELEV.)
SEVENTH REVOLUTION (571.8 - 66.1 min)

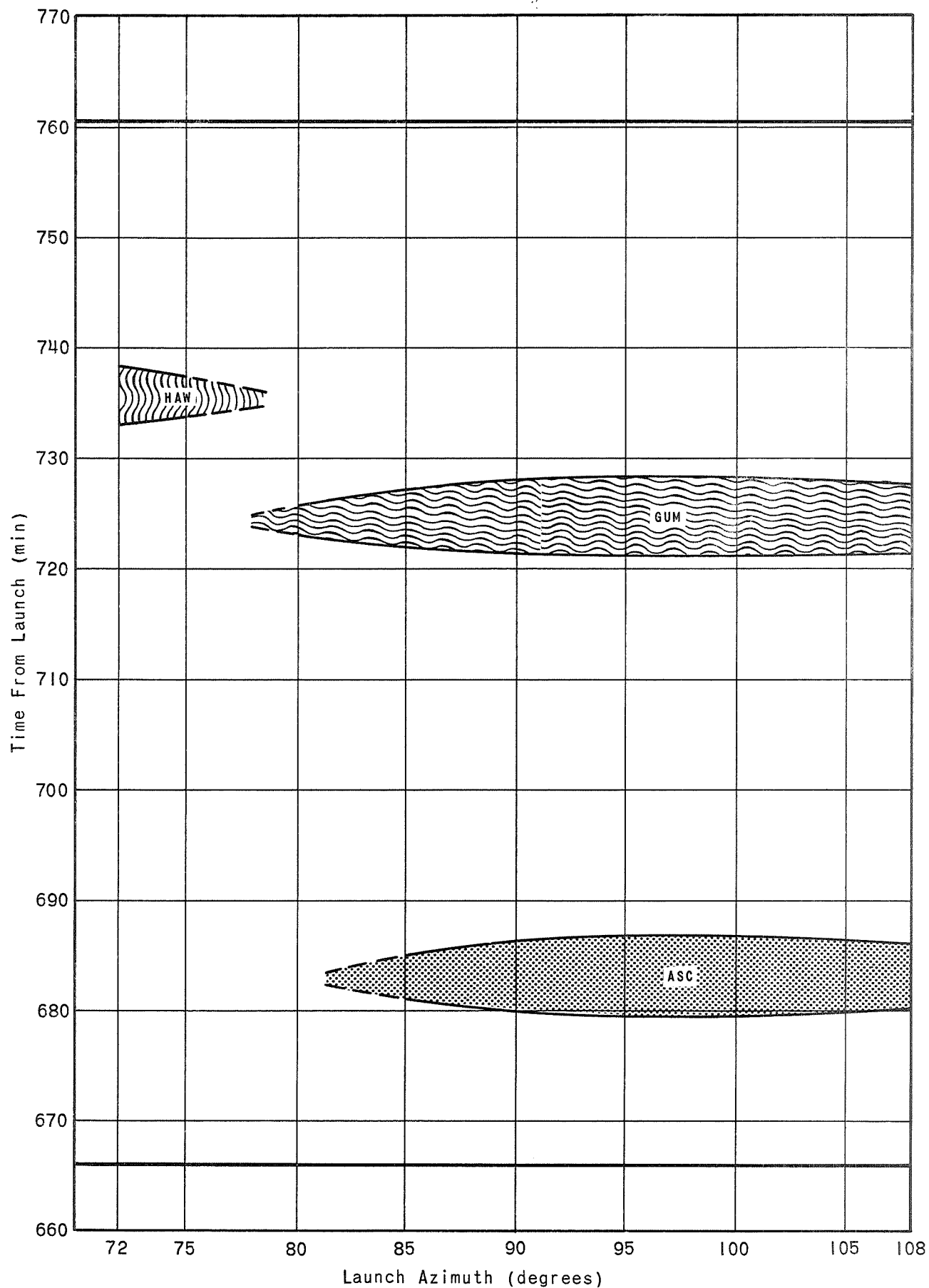


FIGURE 8 COMMUNICATIONS COVERAGE (0° ELEV.)
EIGHTH REVOLUTION (666.1 - 760.4 min)

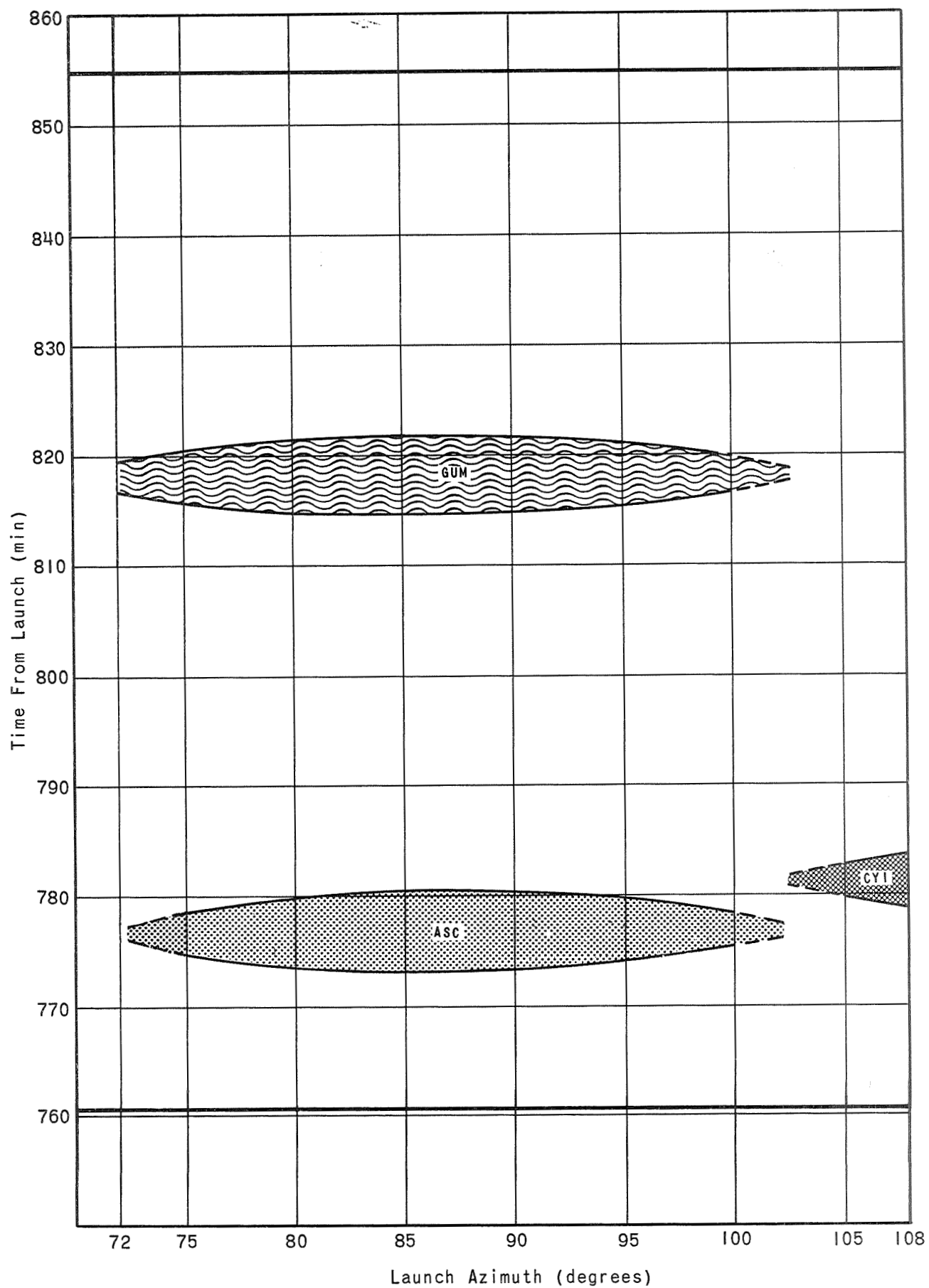


FIGURE 9 COMMUNICATIONS COVERAGE (0° ELEV.)
NINTH REVOLUTION (760.4 - 854.7 min)

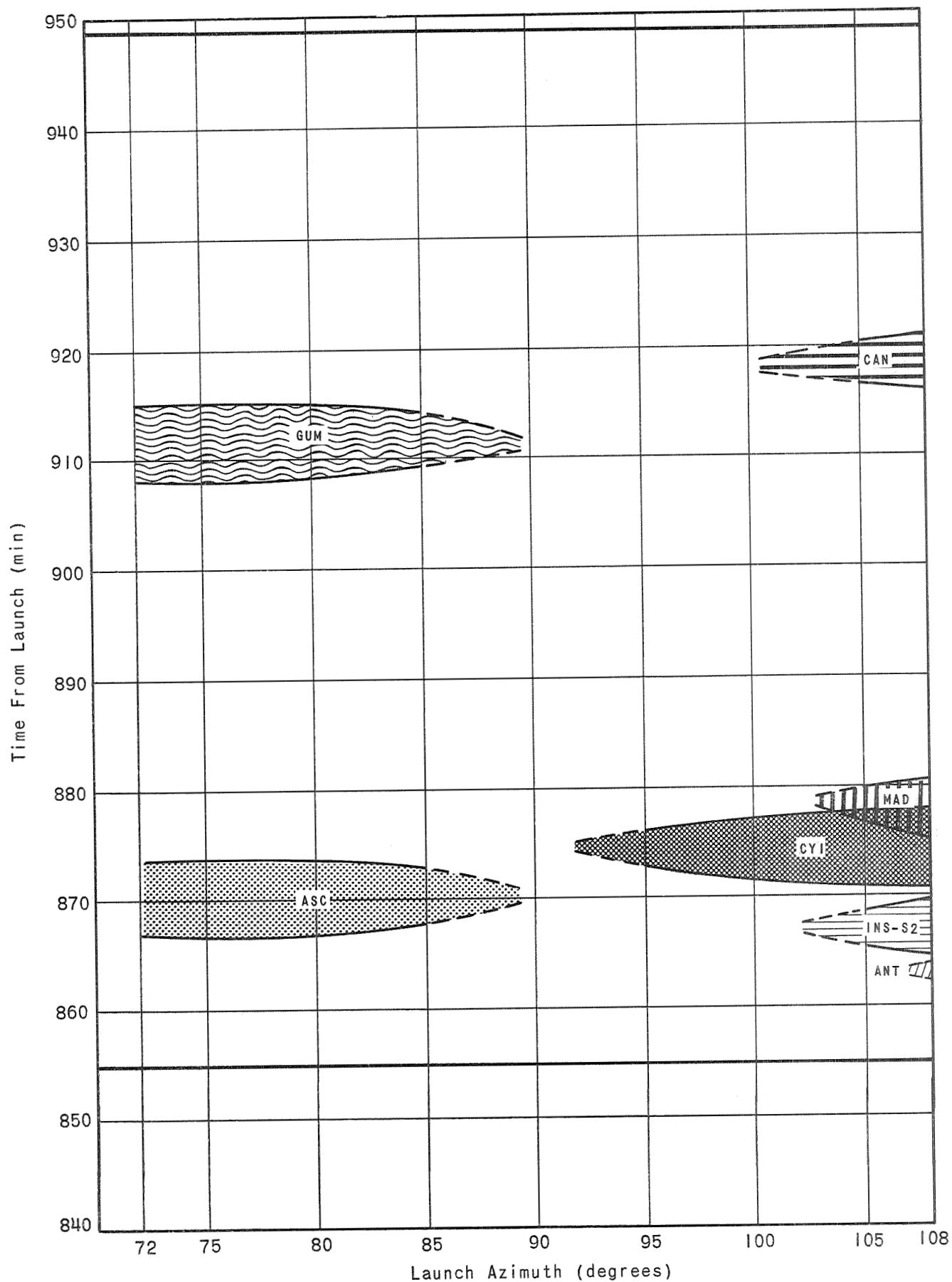


FIGURE 10 COMMUNICATIONS COVERAGE (0° ELEV.)
TENTH REVOLUTION (854.7 - 949.0 min)

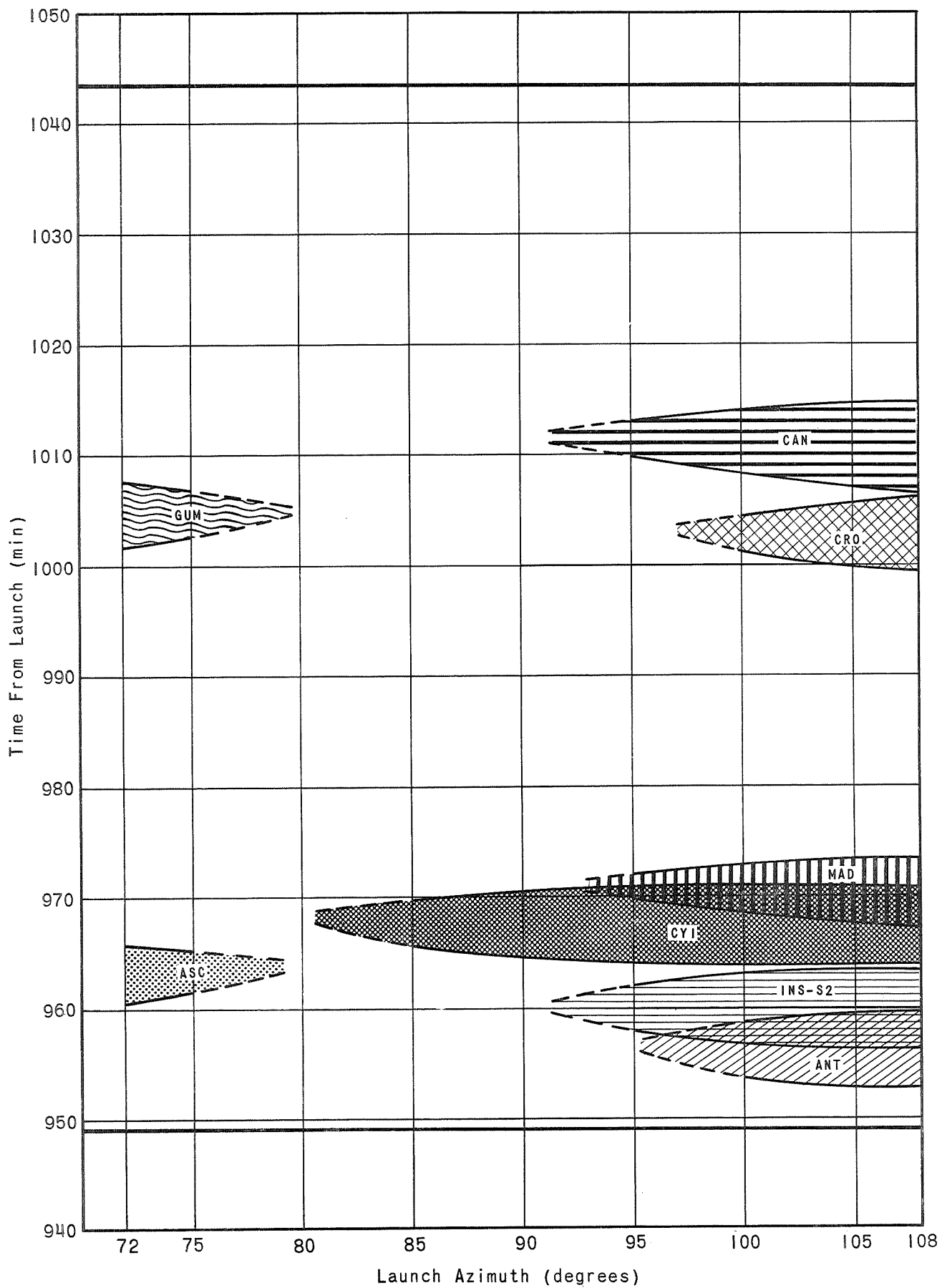


FIGURE 11 COMMUNICATIONS COVERAGE (0° ELEV.)
ELEVENTH REVOLUTION (949.0 - 1043.3 min)

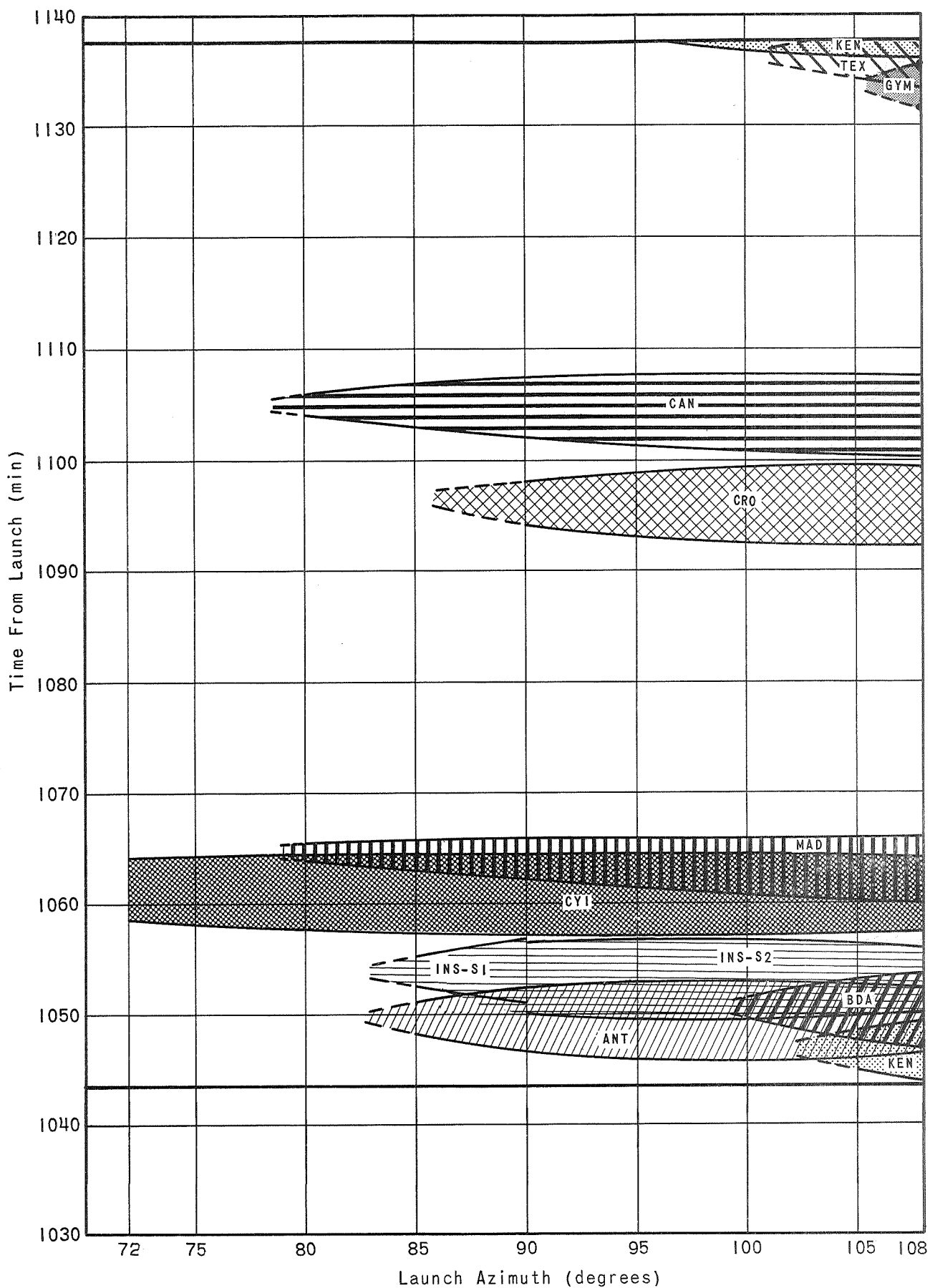


FIGURE 12 COMMUNICATIONS COVERAGE (0° ELEV.)
TWELFTH REVOLUTION (1043.3 - 1137.6 min)

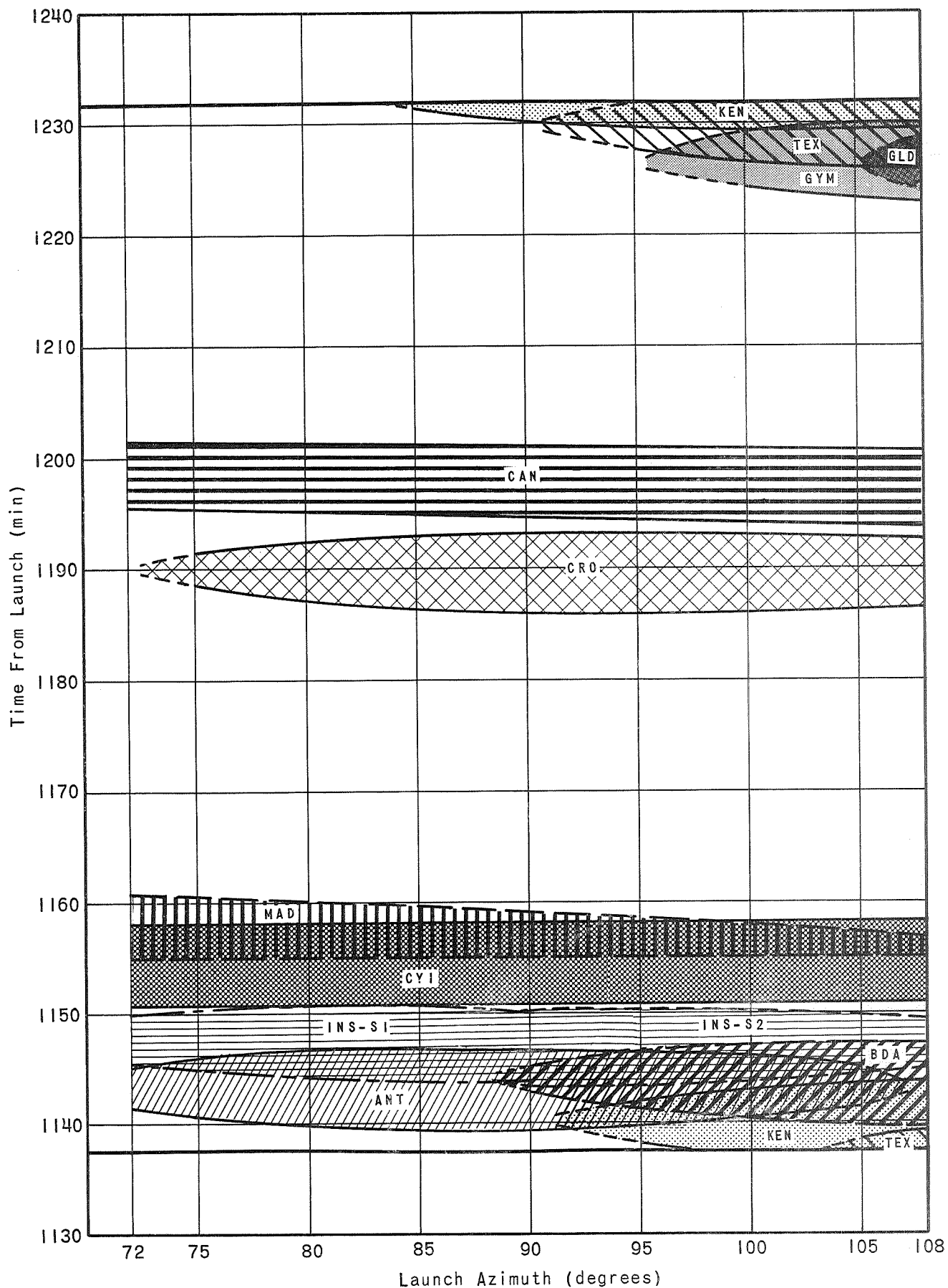


FIGURE 13 COMMUNICATION COVERAGE (0° ELEV.)
THIRTEENTH REVOLUTION (1137.6 - 1231.9 min)

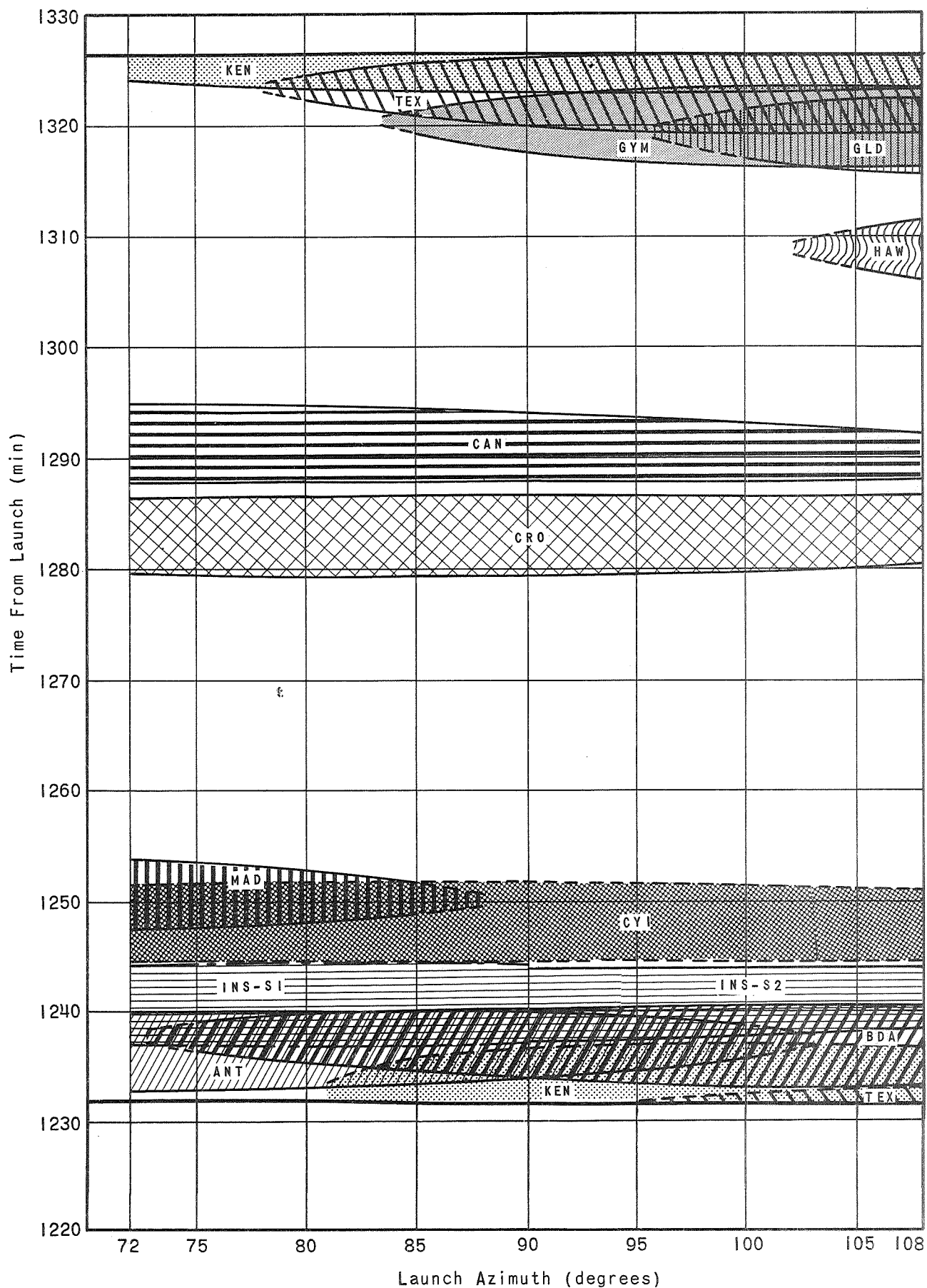


FIGURE 14 COMMUNICATION COVERAGE (0° ELEV.)
FOURTEENTH REVOLUTION (1231.9 - 1326.2 min)

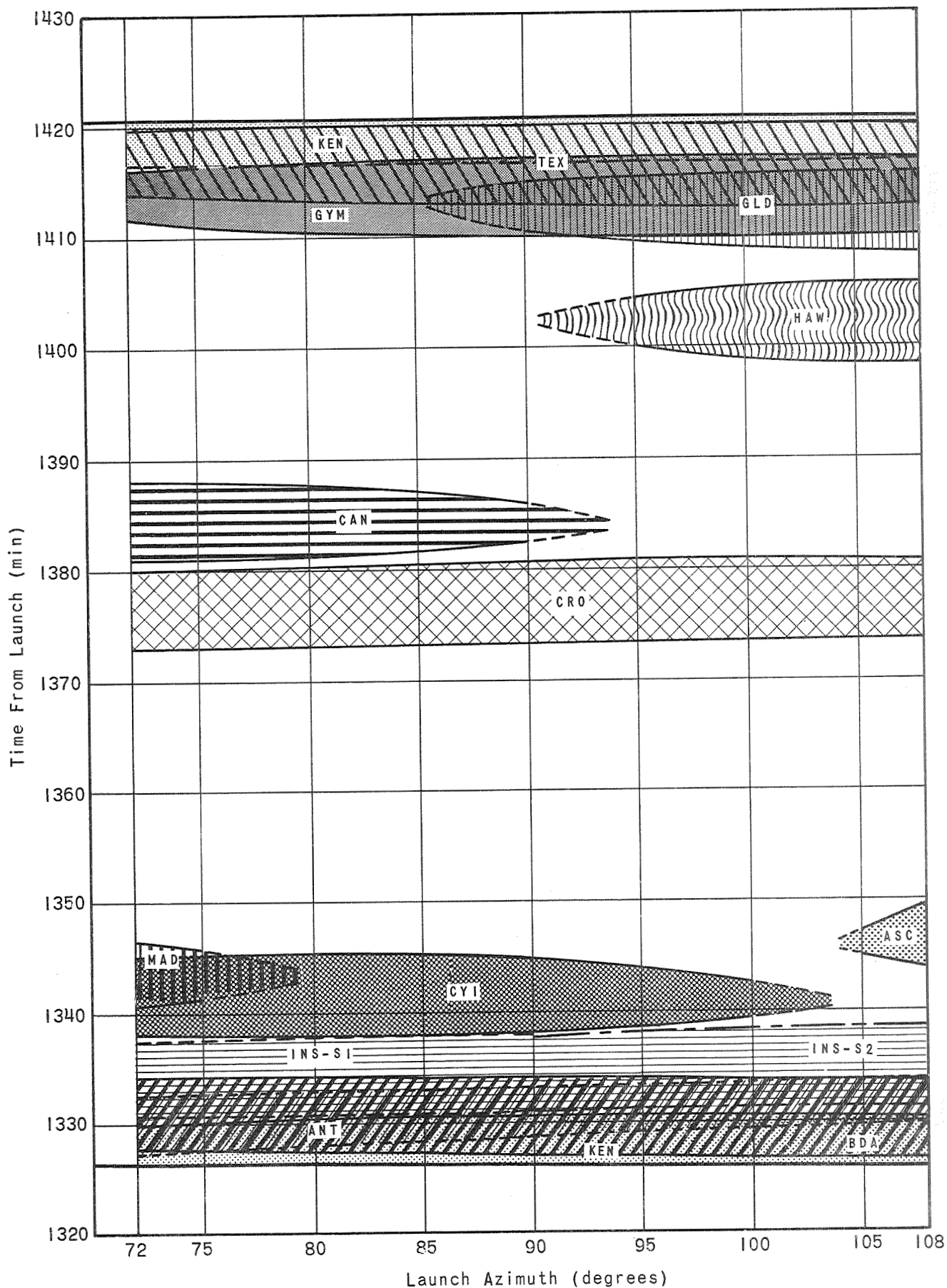


FIGURE 15 COMMUNICATION COVERAGE (0° ELEV.)
FIFTEENTH REVOLUTION (1326.2 - 1420.5 min)

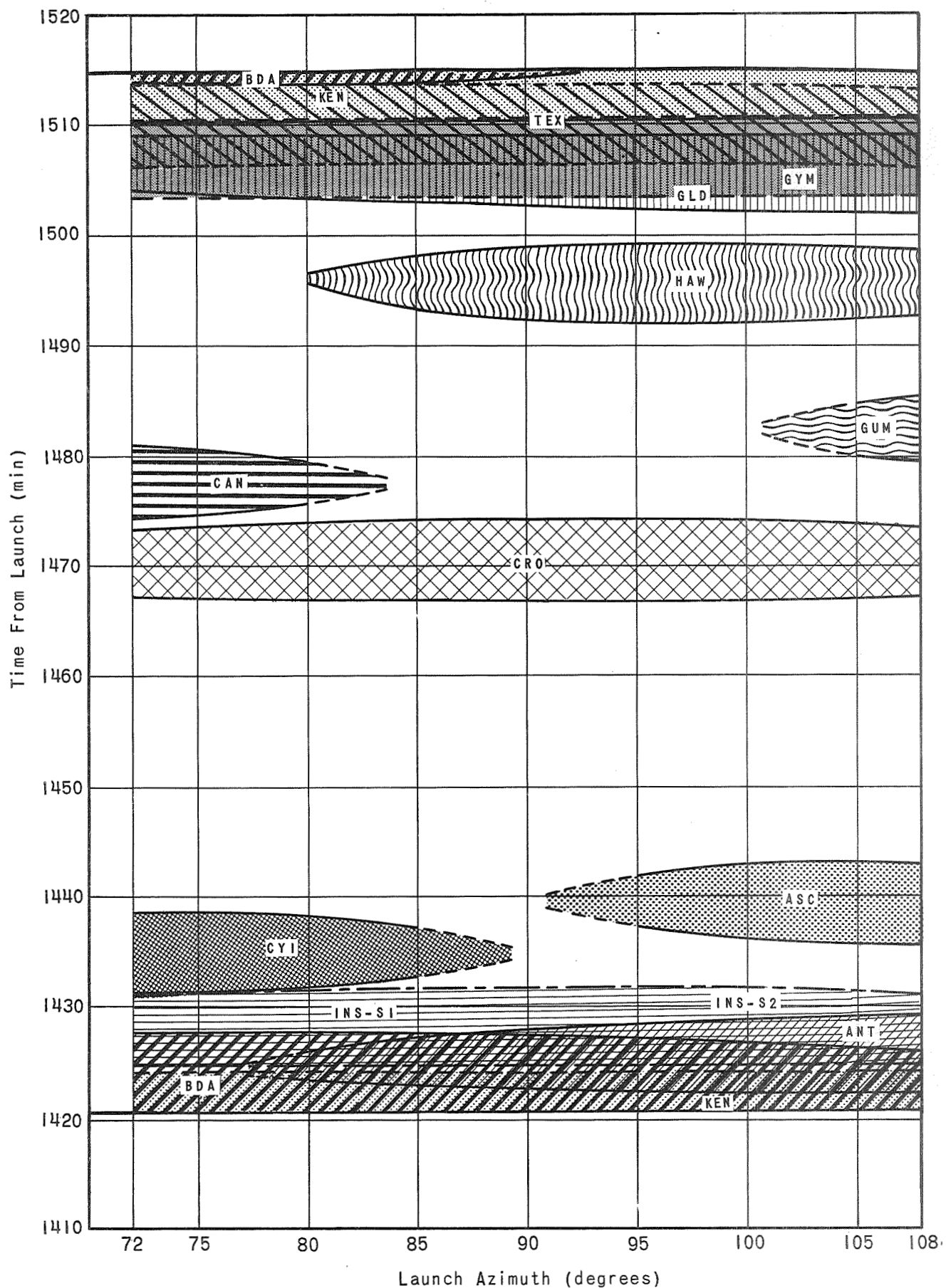


FIGURE 16 COMMUNICATION COVERAGE (0° ELEV.)
SIXTEENTH REVOLUTION (1420.5 - 1514.8 min)

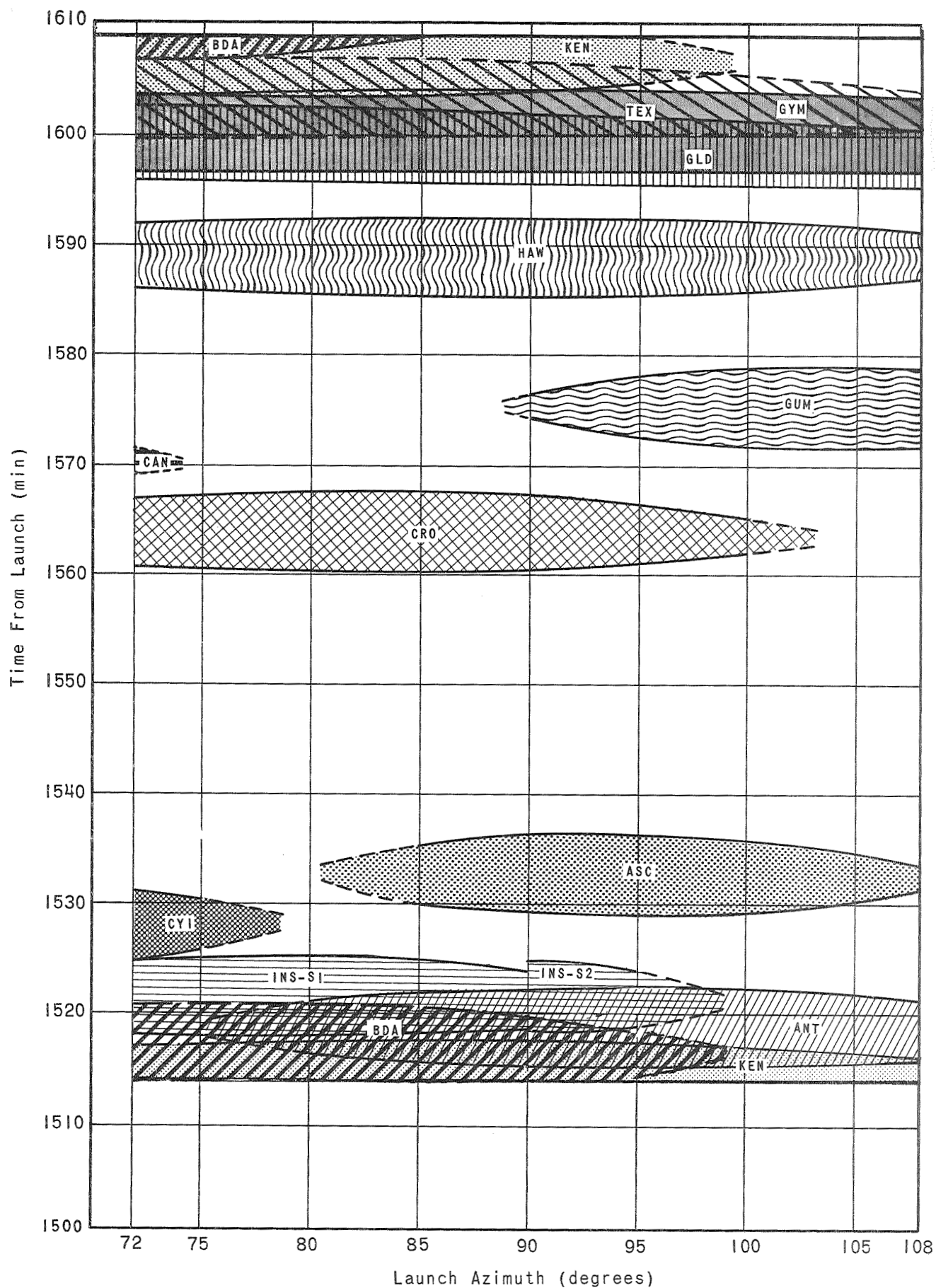


FIGURE 17 COMMUNICATIONS COVERAGE (0° ELEV.)
SEVENTEENTH REVOLUTION (1514.8 - 1609.1 min)

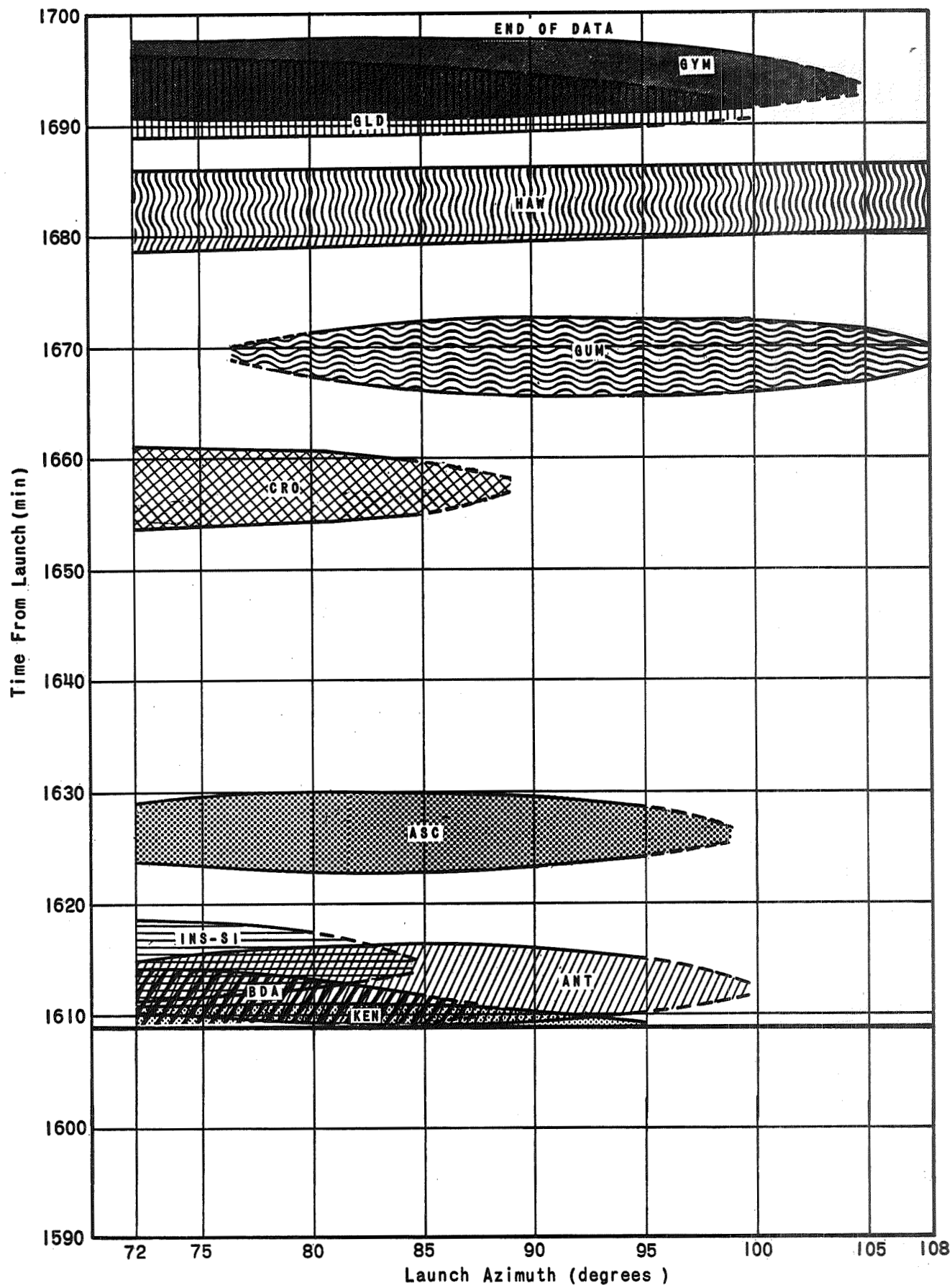


FIGURE 18 COMMUNICATION COVERAGE (0° ELEV.)
EIGHTEENTH REVOLUTION (1609.1 - 1703.4 min)

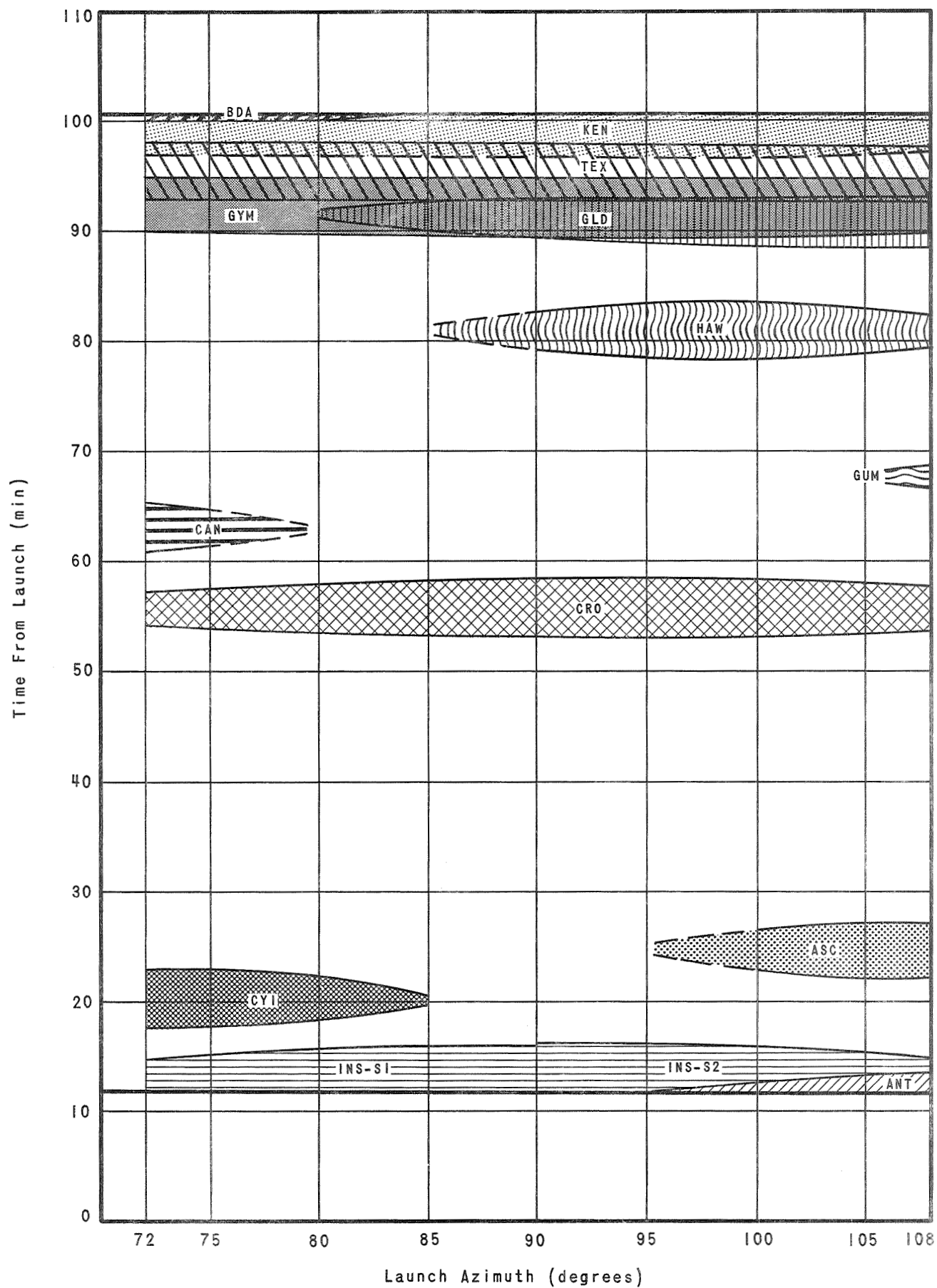


FIGURE 19 TRACKING COVERAGE (5° ELEV.)
FIRST REVOLUTION (11.9 - 100.3 min)

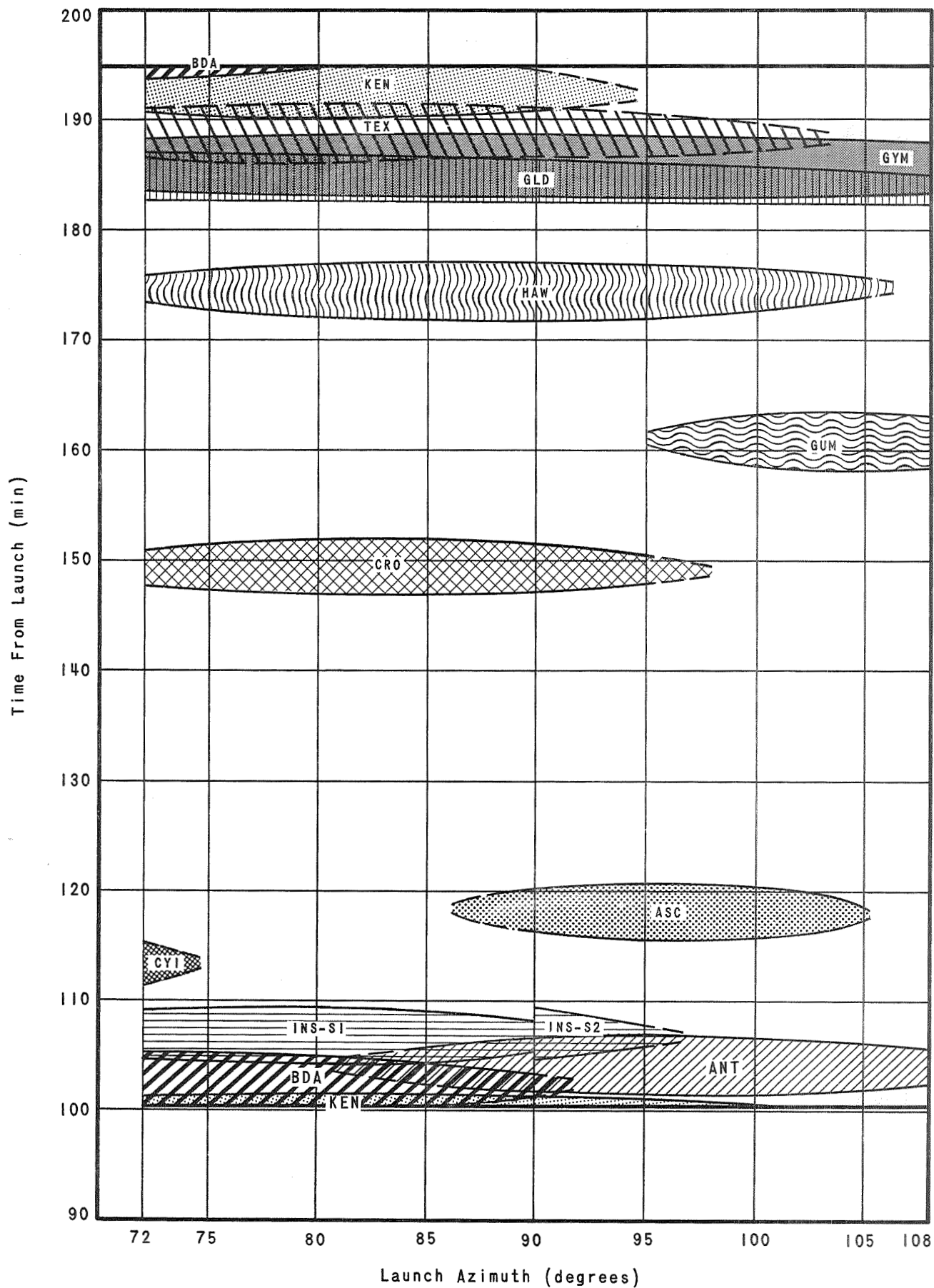


FIGURE 20 TRACKING COVERAGE (5° ELEV.)
SECOND REVOLUTION (100.3 - 194.6 min)

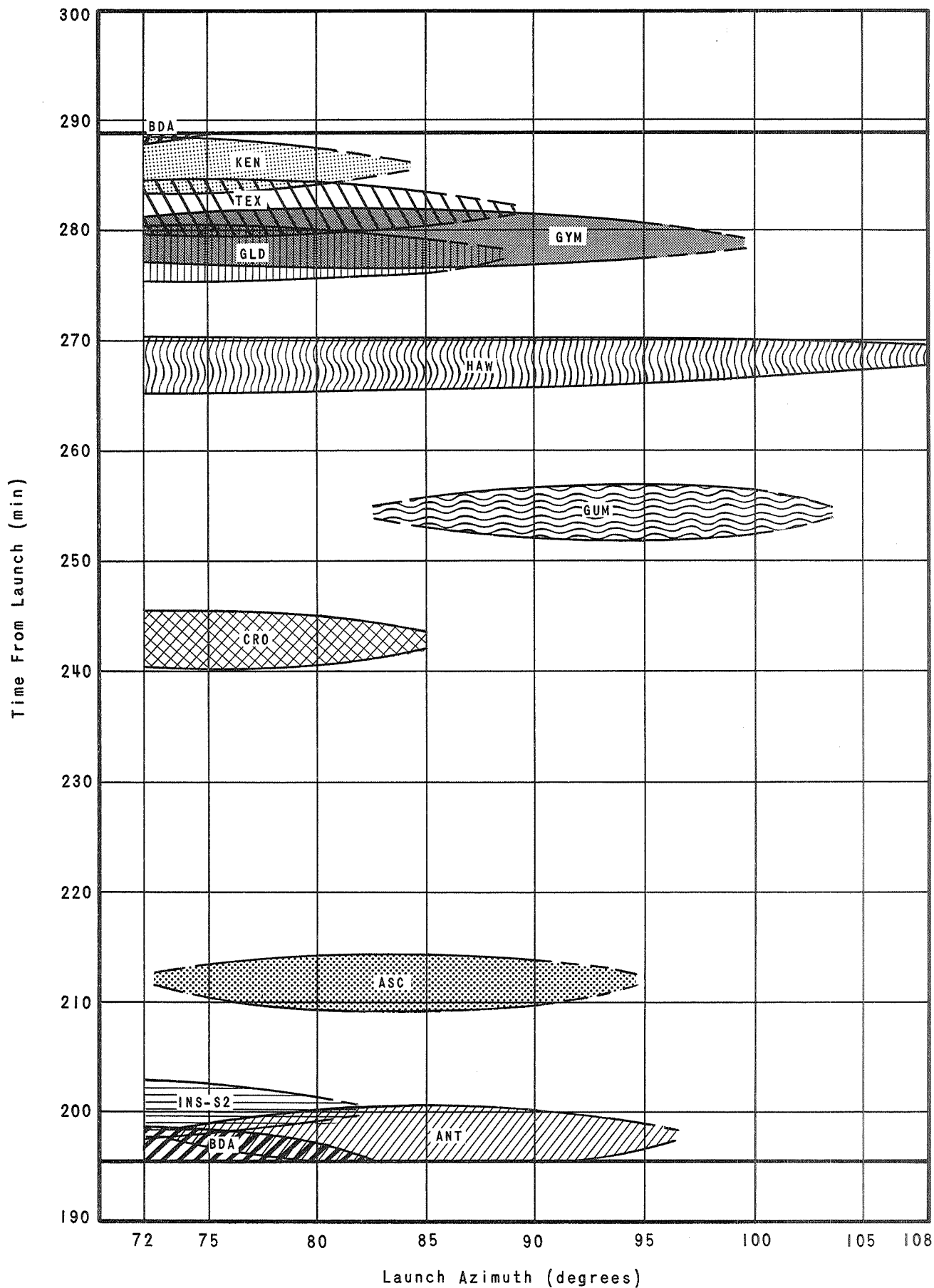


FIGURE 21 TRACKING COVERAGE (5 ELEV.)
THIRD REVOLUTION (194.6 - 288.9 min)

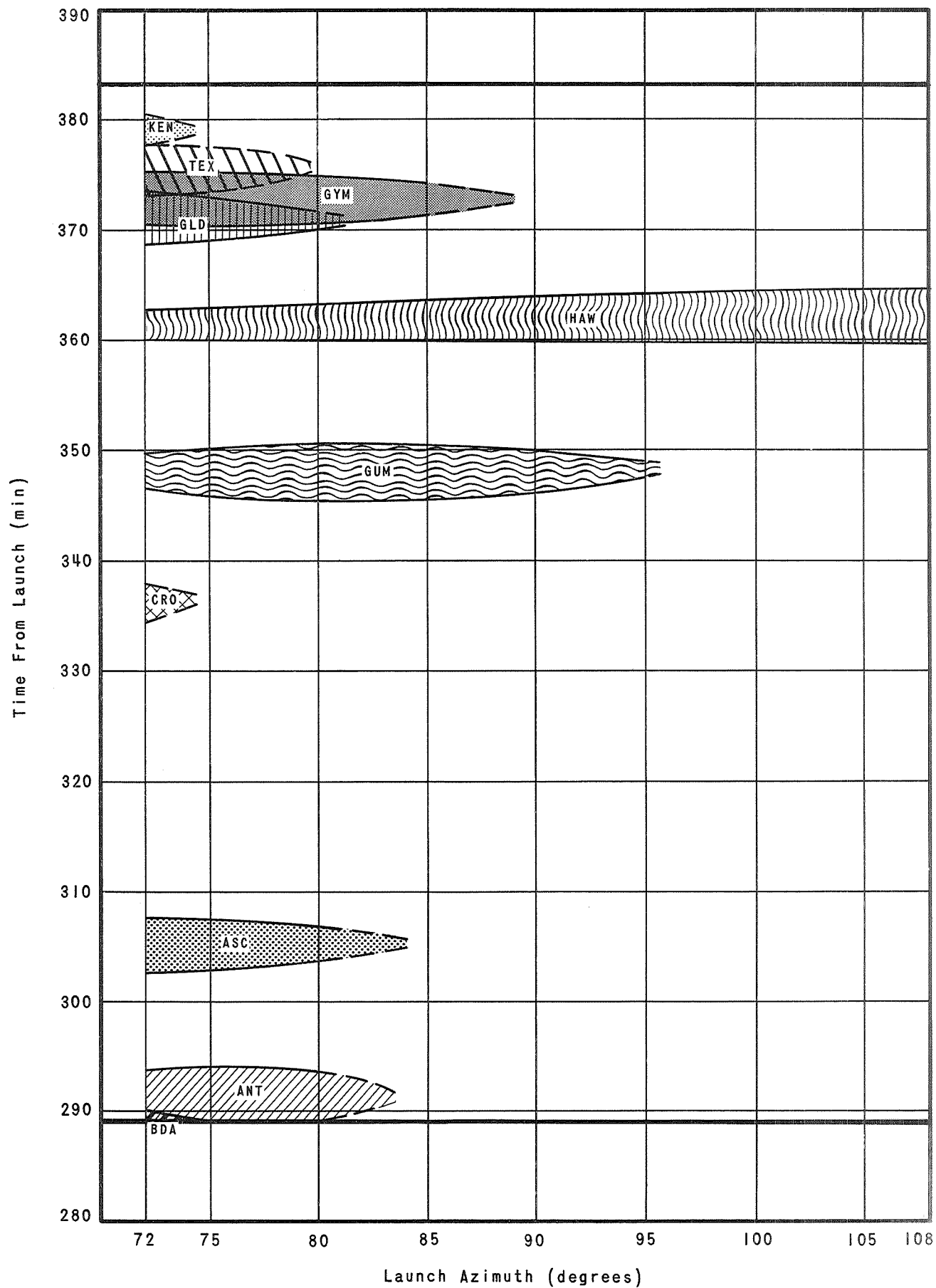


FIGURE 22 TRACKING COVERAGE (5° ELEV.)
FOURTH REVOLUTION (288.9 - 383.2 min)

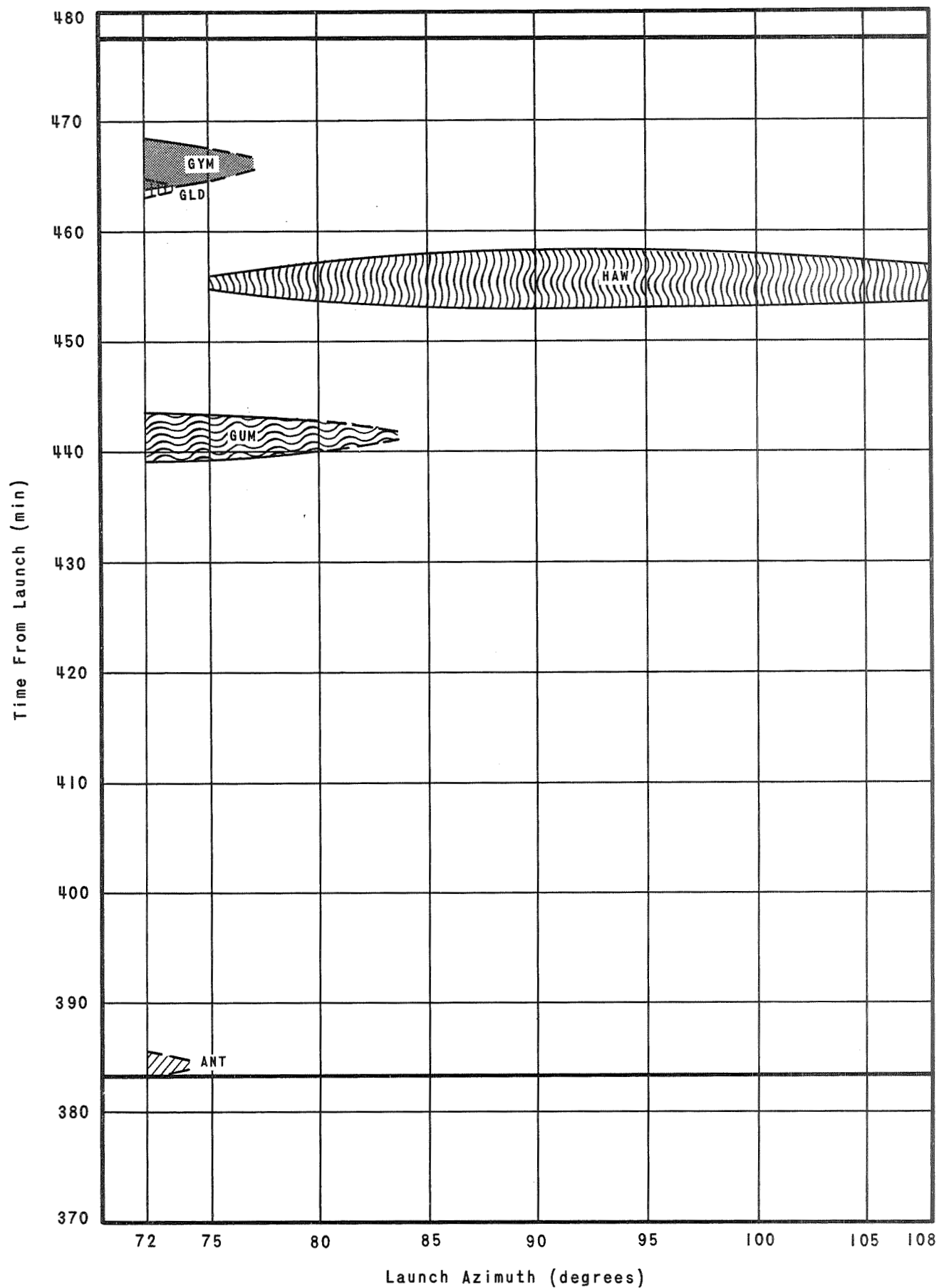


FIGURE 23 TRACKING COVERAGE (5° ELEV.)
FIFTH REVOLUTION (383.2 - 477.5 min)

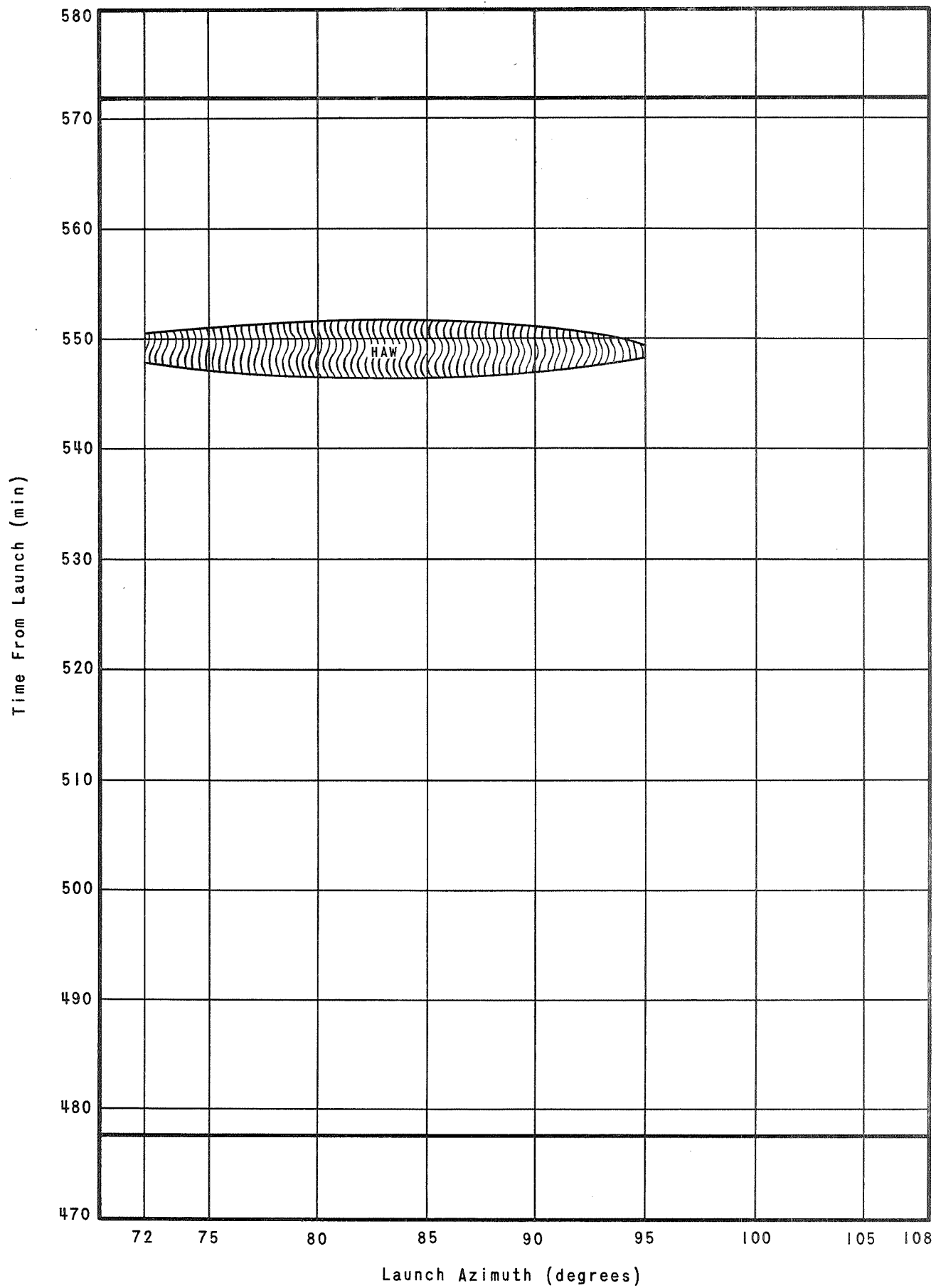


FIGURE 24 TRACKING COVERAGE (5° ELEV.)
SIXTH REVOLUTION (477.5 - 571.8 min)

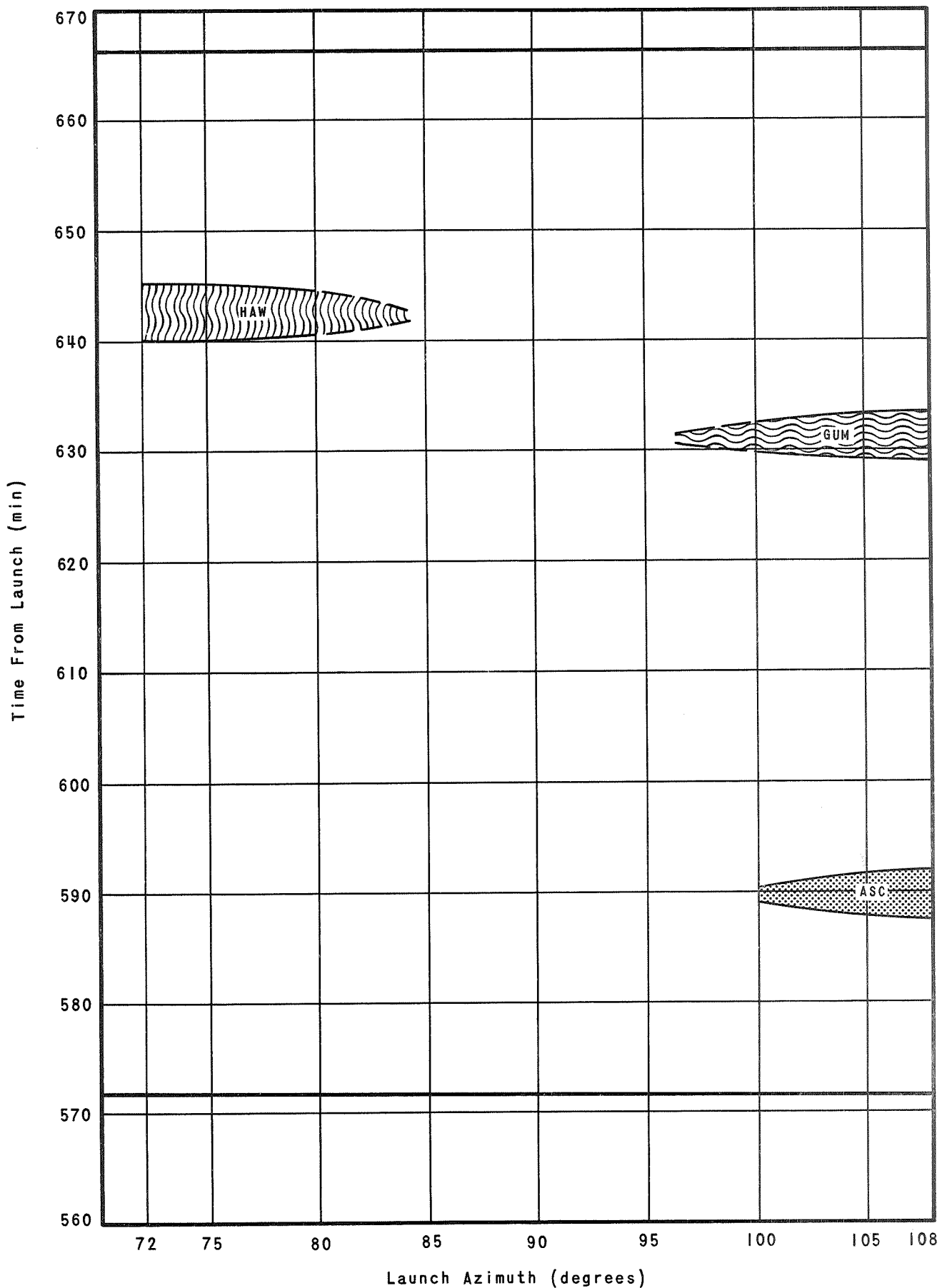


FIGURE 25 TRACKING COVERAGE (5° ELEV.)
SEVENTH REVOLUTION (571.8 - 666.1 min)

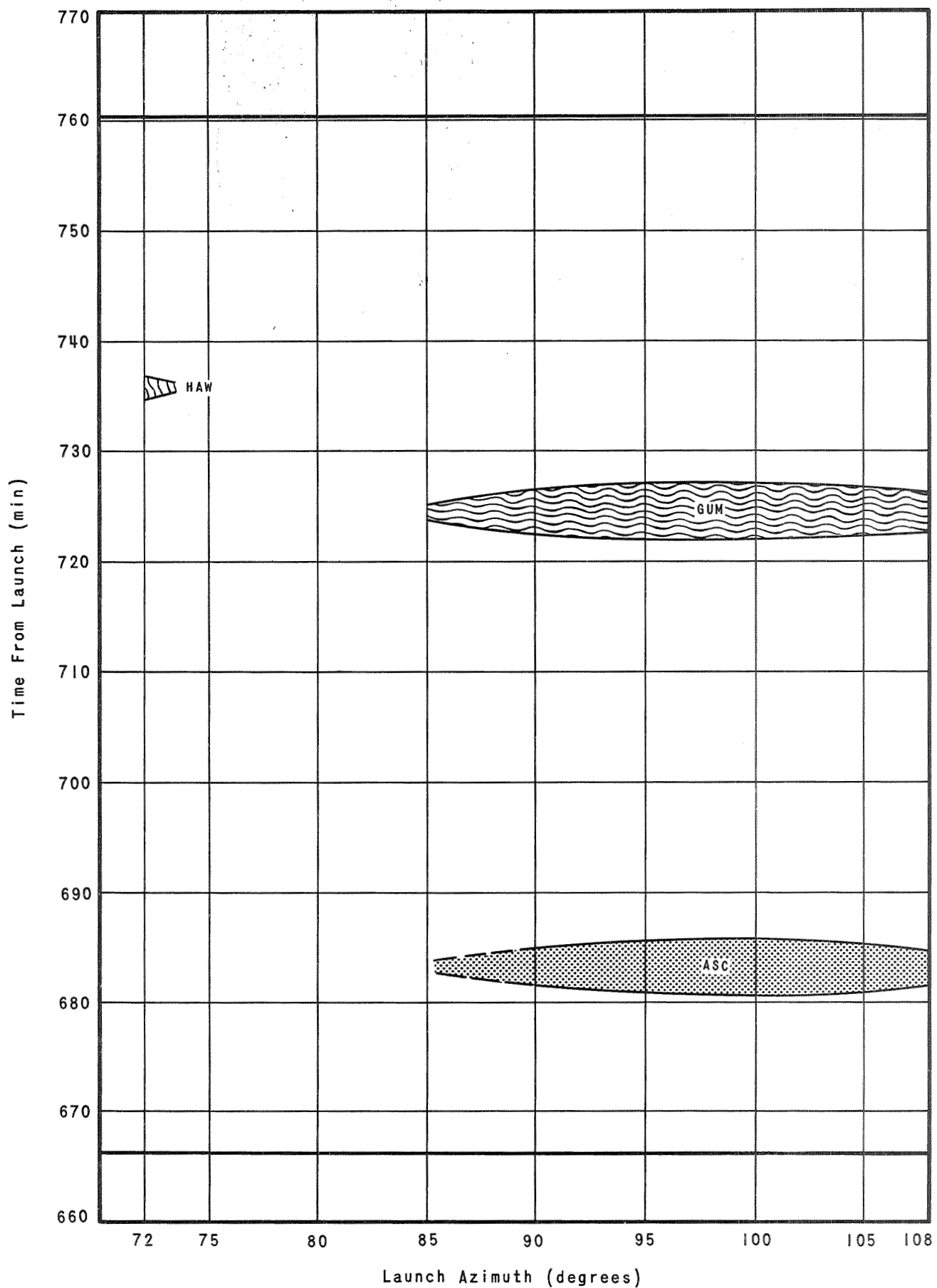


FIGURE 26 TRACKING COVERAGE (5° ELEV.)
EIGHTH REVOLUTION (666.1 - 760.4 min)

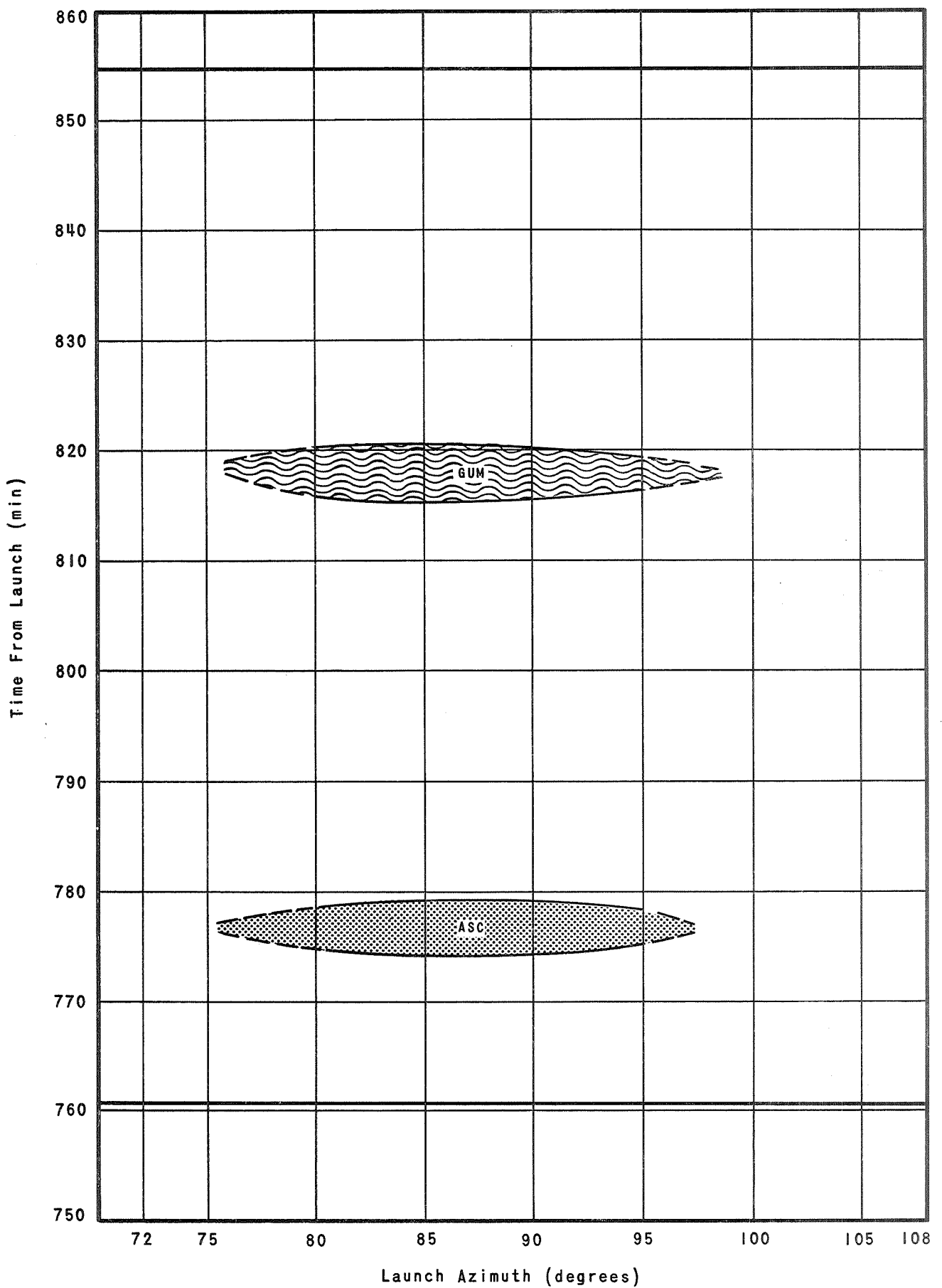


FIGURE 27 TRACKING COVERAGE (5° ELEV.)
NINTH REVOLUTION (760.4 - 854.7 min)

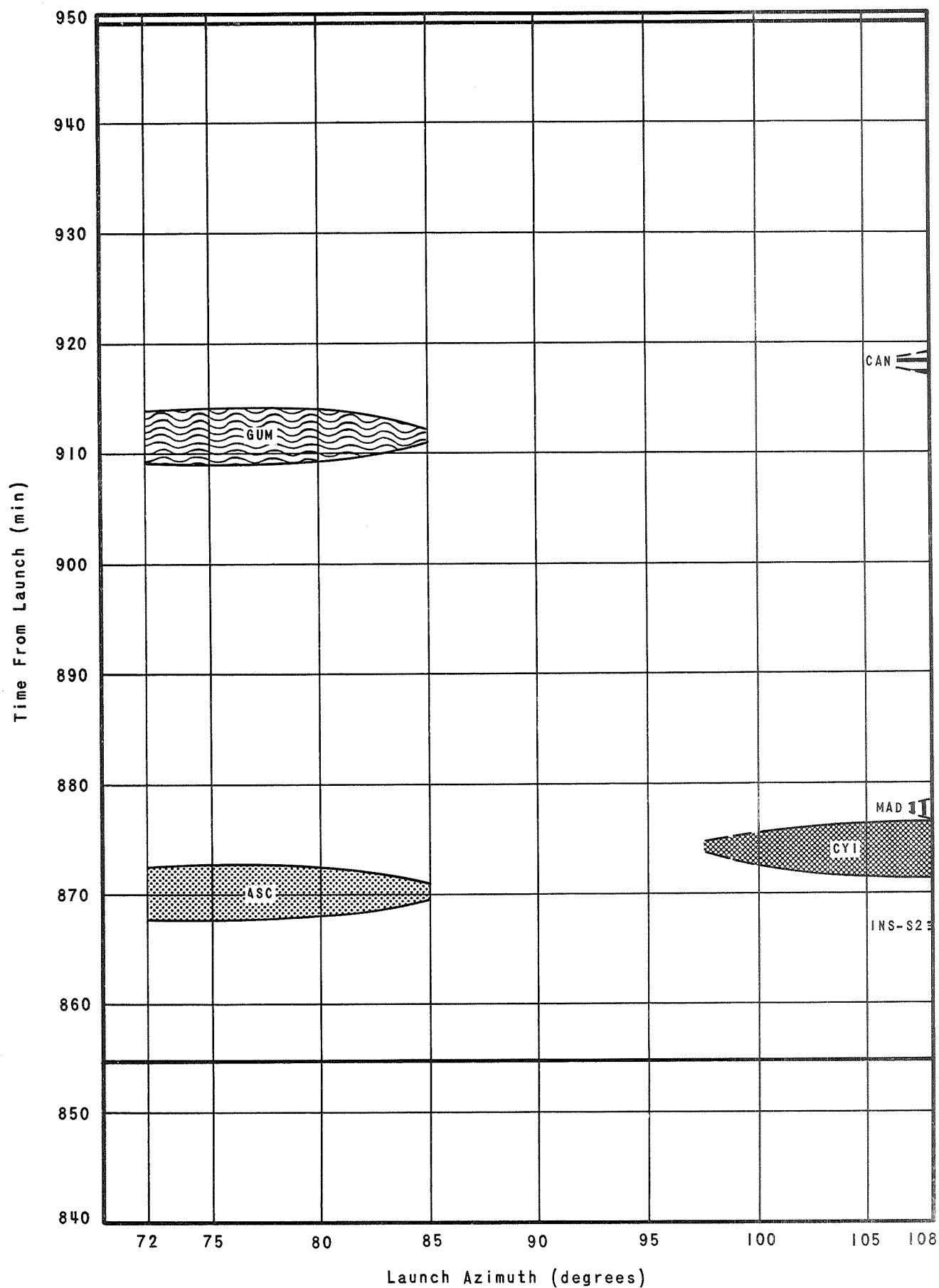


FIGURE 28 TRACKING COVERAGE (5° ELEV.)
TENTH REVOLUTION (854.7 - 949.0 min)

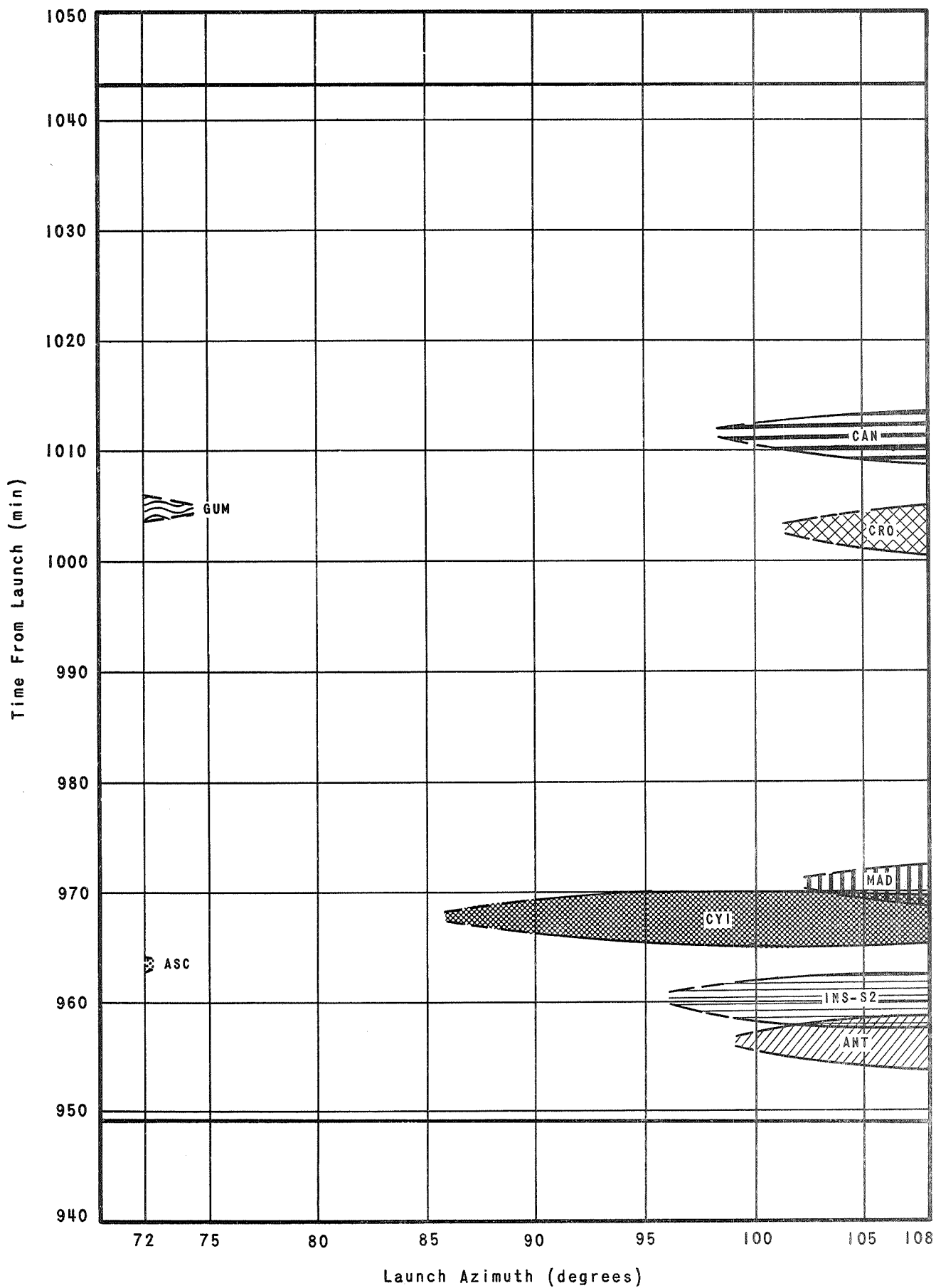


FIGURE 29 TRACKING COVERAGE (5° ELEV.)
ELEVENTH REVOLUTION (949.0 - 1043.3 min)

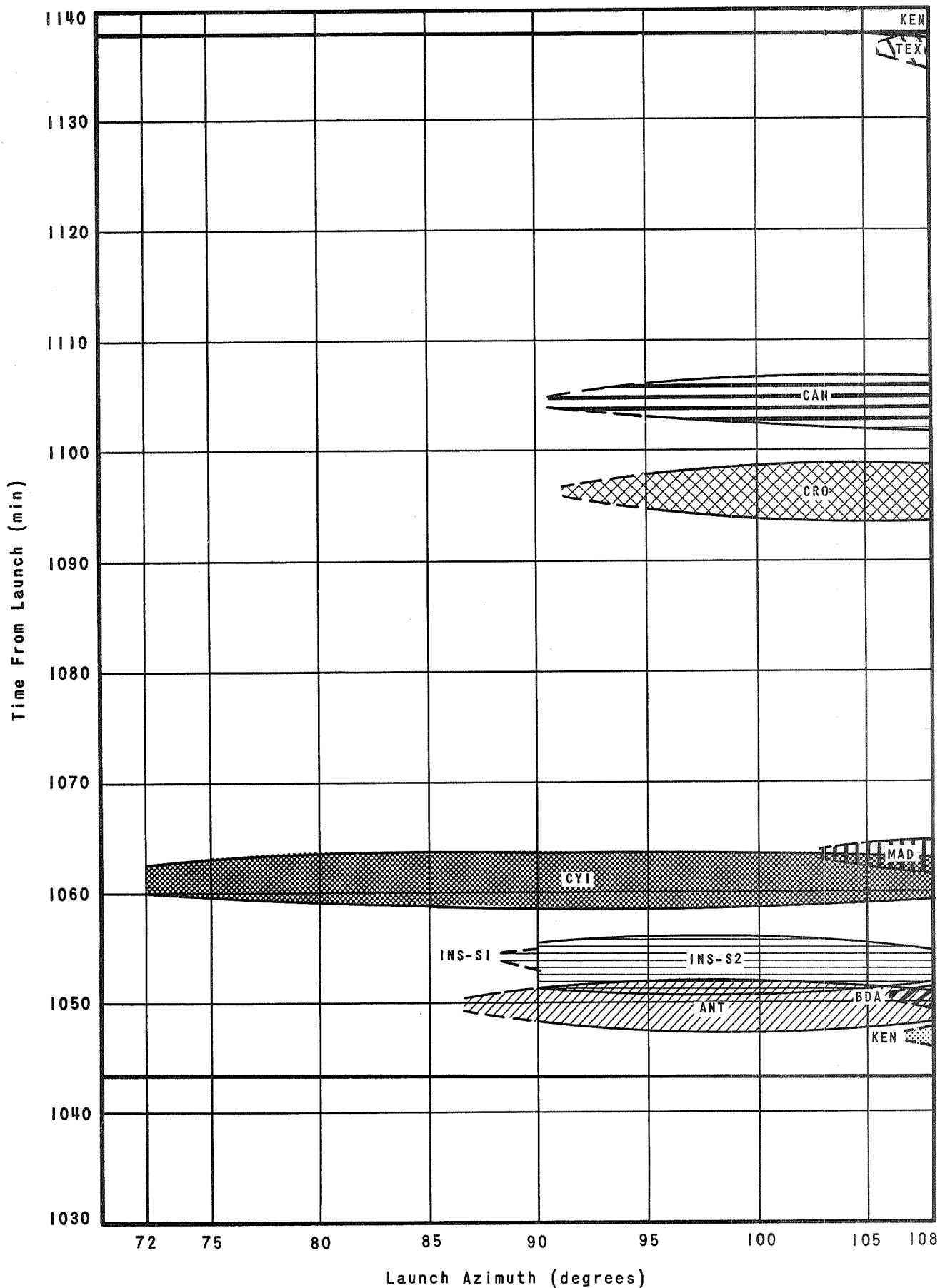


FIGURE 30 TRACKING COVERAGE (5° ELEV.)
TWELFTH REVOLUTION (1043.3 - 1137.6 min)

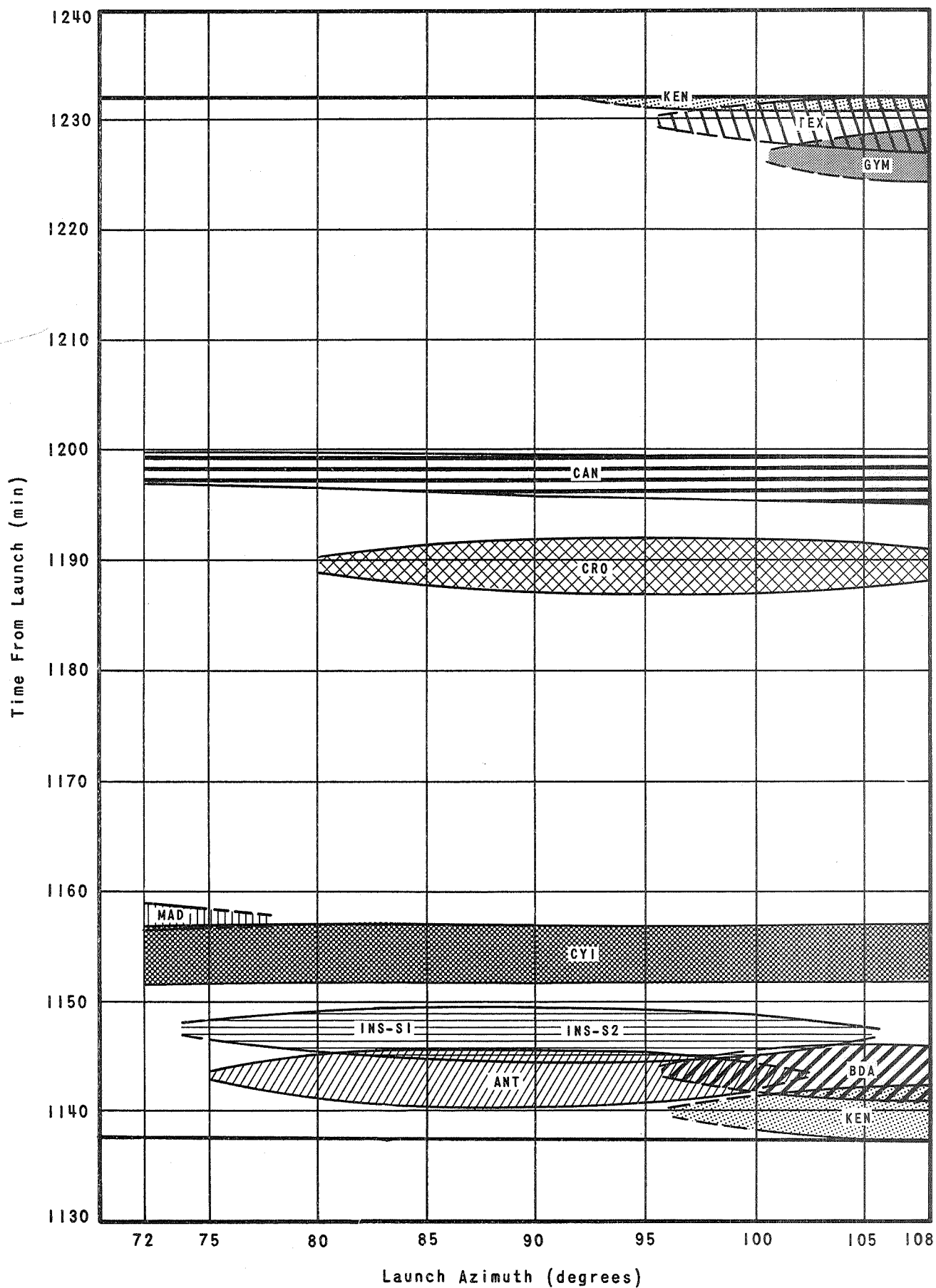


FIGURE 31 TRACKING COVERAGE (5° ELEV.)
THIRTEENTH REVOLUTION (1137.6 - 1231.9 min)

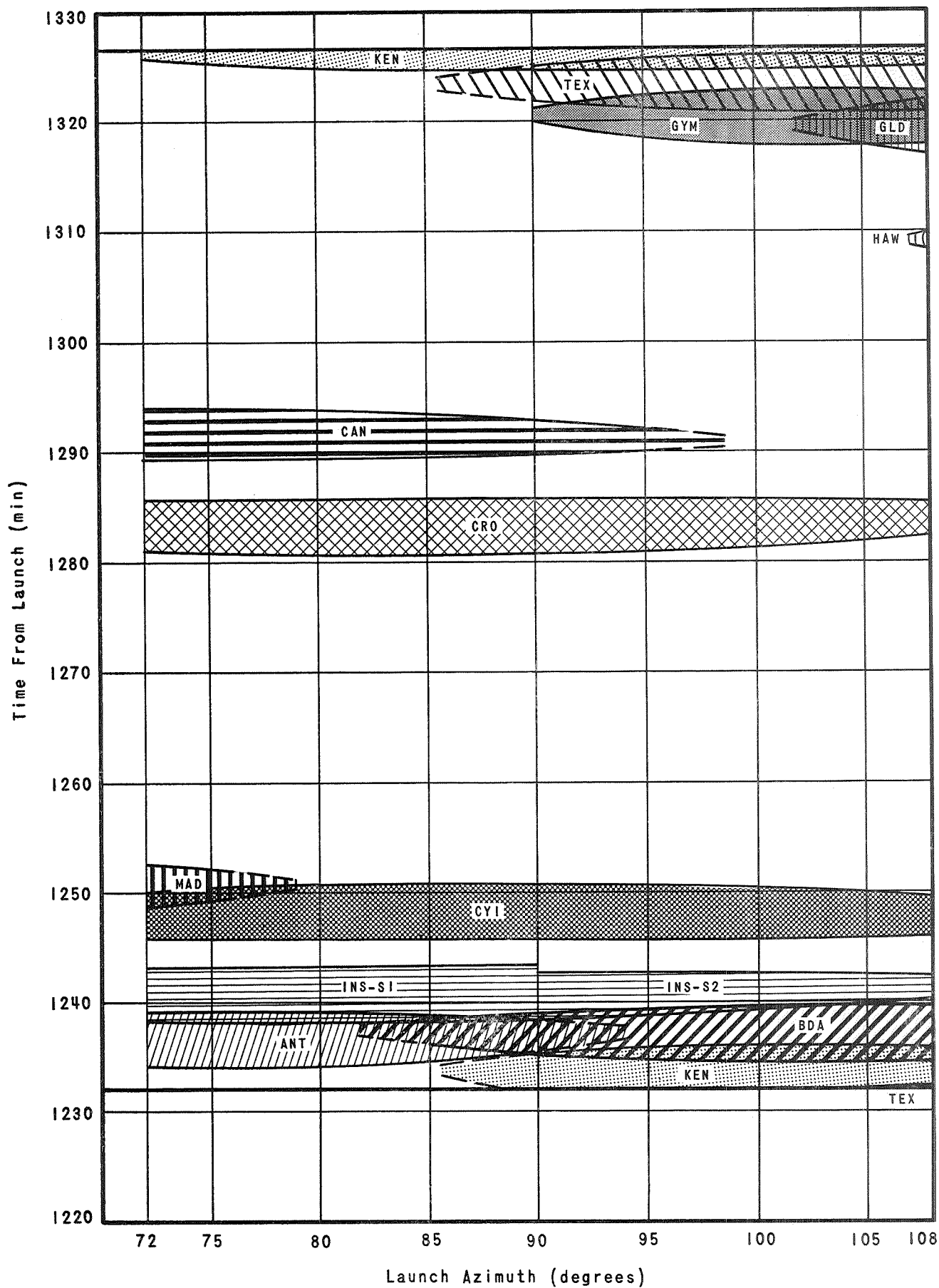


FIGURE 32 TRACKING COVERAGE (5° ELEV.)
FOURTEENTH REVOLUTION (1231.9 - 1326.2 min)

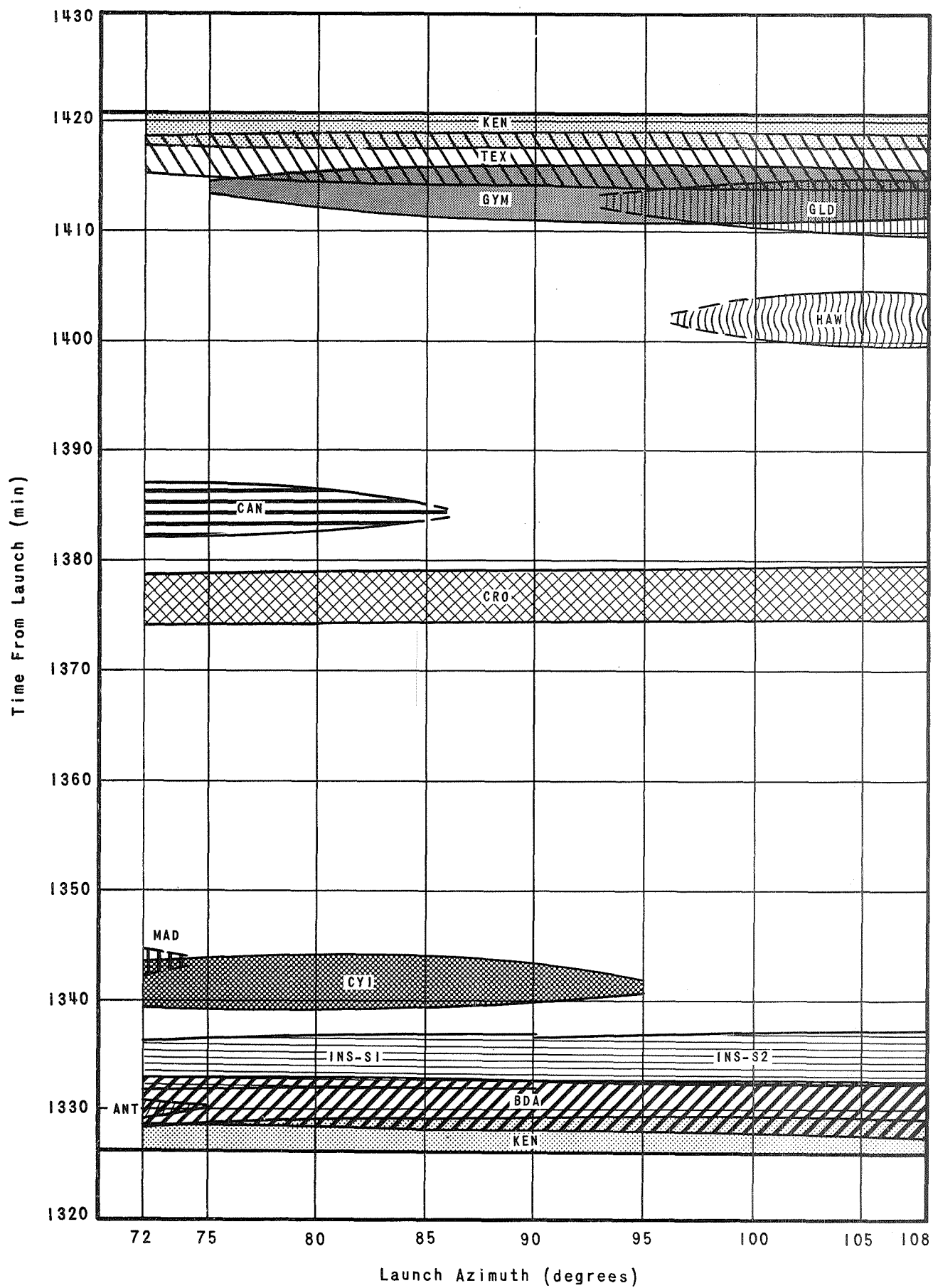


FIGURE 33 TRACKING COVERAGE (5° ELEV.)
FIFTEENTH REVOLUTION (1326.2 - 1420.5 min)

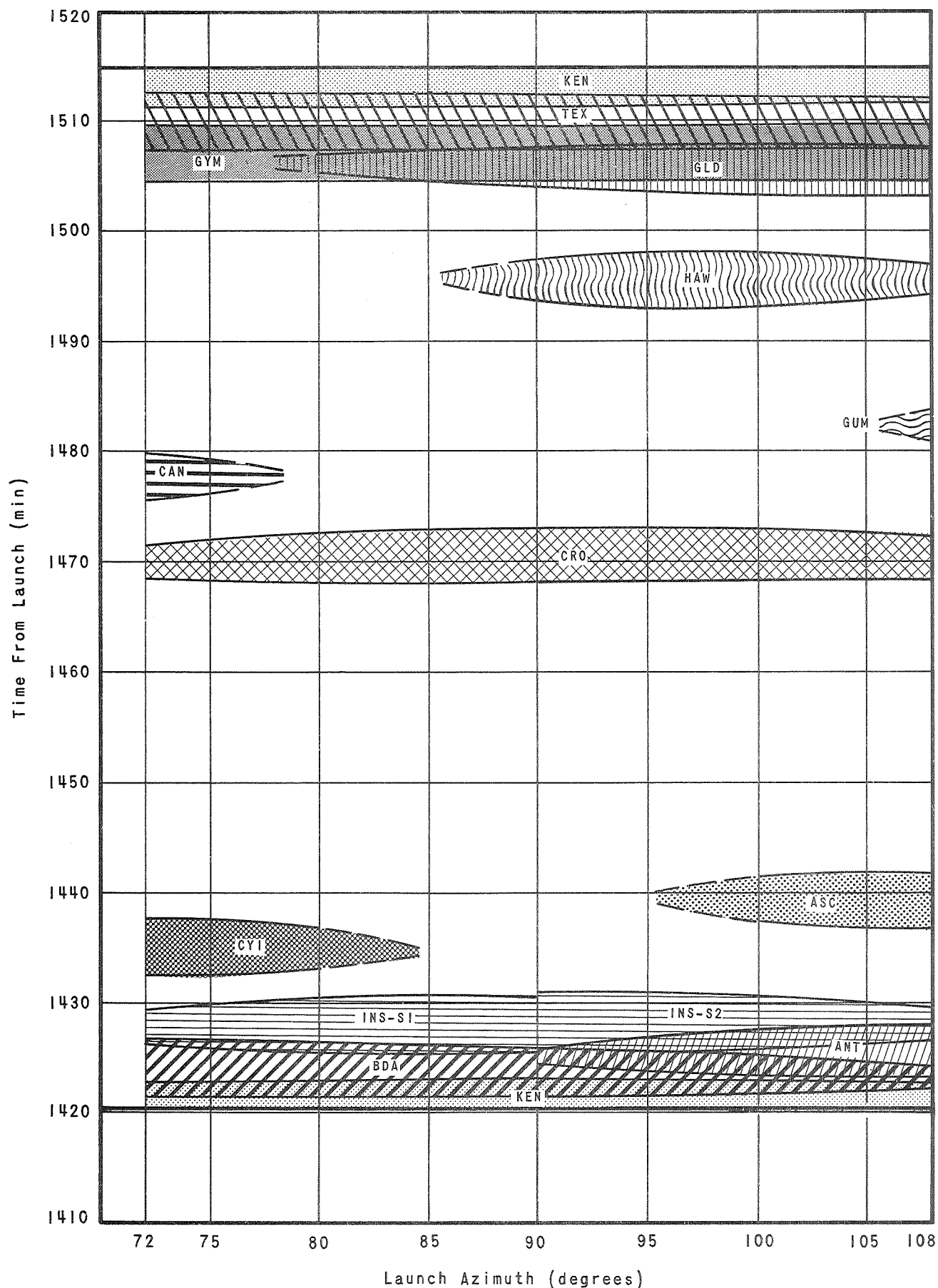


FIGURE 34 TRACKING COVERAGE (5° ELEV.)
SIXTEENTH REVOLUTION (1420.5 - 1514.8 min)

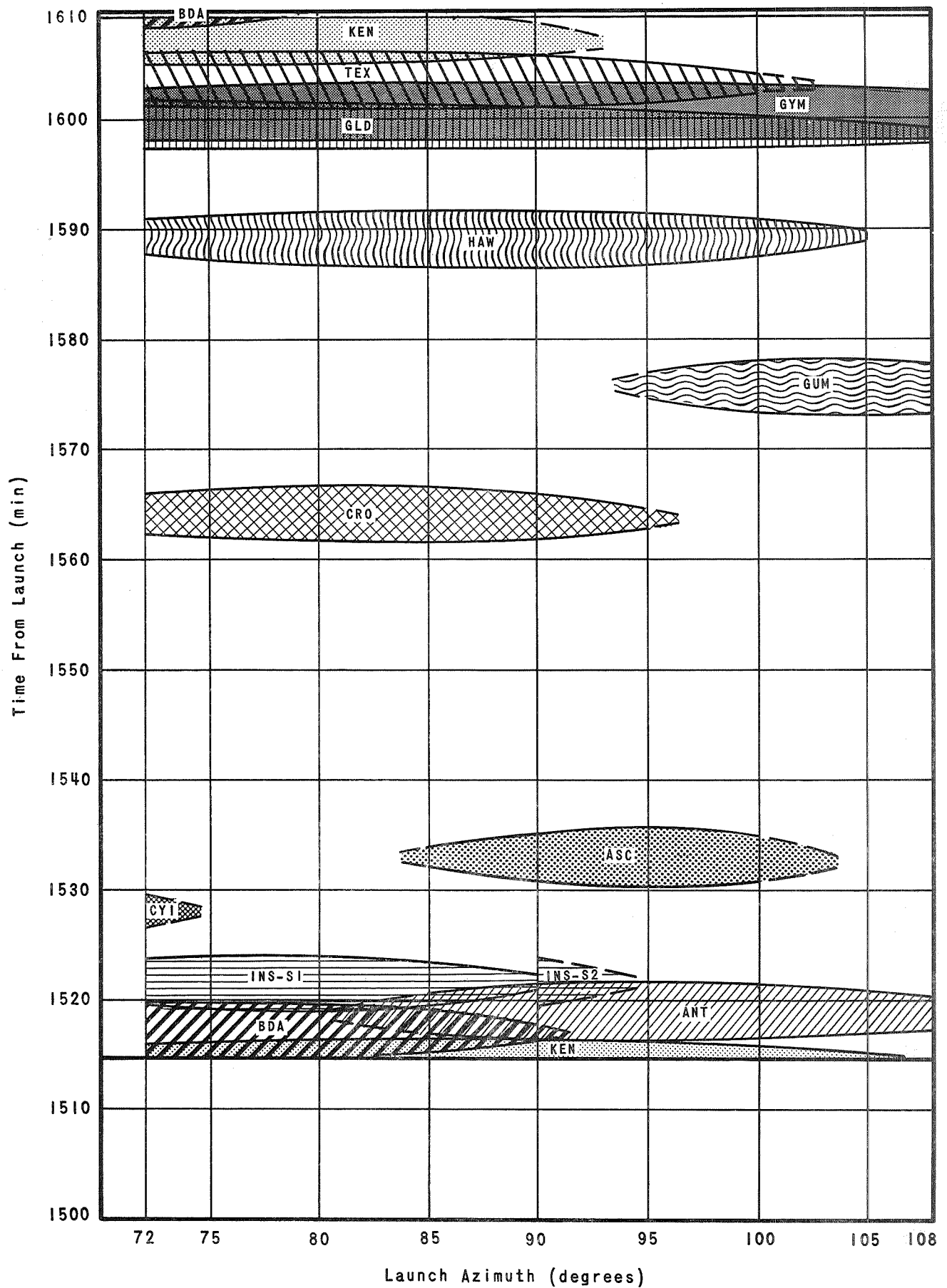


FIGURE 35 TRACKING COVERAGE (5° ELEV.)
SEVENTEENTH REVOLUTION (1514.8 - 1609.1 min)

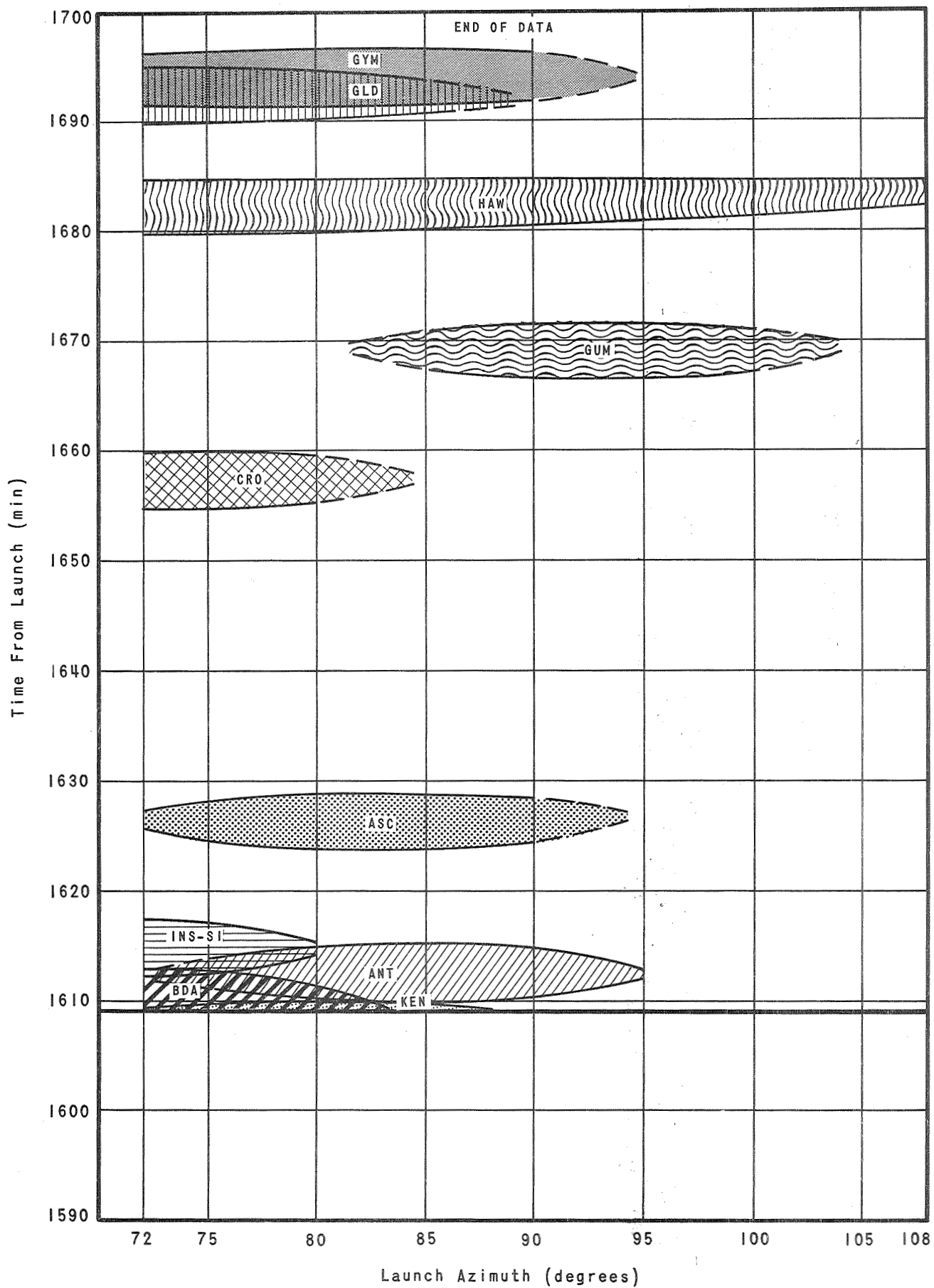


FIGURE 36 TRACKING COVERAGE (5° ELEV.)
EIGHTEENTH REVOLUTION (1609.1 - END OF DATA)